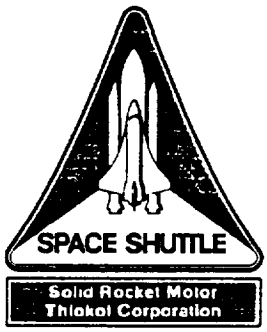
TWR-64222



Appendix C
Nozzle PFORs

Final Postflight Hardware Evaluation Report RSRM-29 (STS-54)

September 1993

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

Contract No.	NAS8-38100
DR No.	4-23
WBS No.	4C601-04-01
ECS No.	SS4772

Thiokol CORPORATION
SPACE OPERATIONS

P.O. Box 707, Brigham City, Utah 84302-0707 (801) 863-3511

NOZZLE REQUIRED EVALUATION FORMS LIST

PFOR #	Title	Side	Joint, Part, or Location	Final Report Page Number
C-1	Nozzle Assembly Quick-look Condition	Left	N/A	C-1
C-2	Internal Nozzle Joint Condition	Left	Joint #2	C-2
C-3	Nose Inlet-to-Flex Bearing-to-Cowl Joint Condition Drawing Worksheet	Left	Joint #2	C-3
C-2	Internal Nozzle Joint Condition	Left	Joint #3	C-4
C-4	Nose Inlet-to-Throat Joint Condition Drawing Worksheet	Left	Joint #3	C-5
C-2	Internal Nozzle Joint Condition	Left	Joint #4	C-6
C-5	Throat-to-Forward Exit Cone Joint Condition Drawing Worksheet	Left	Joint #4	C-7
C-2	Internal Nozzle Joint Condition	Left	Joint #5	C-8
C-6	Aft End Ring-to-Fixed Housing Joint Condition Drawing Worksheet	Left	Joint #5	C-9
C-7	Cowl Insulation Segment Condition	Left	Cowl	C-10
C-8	Flexible Bearing, Flexible Bearing Protector, and Flexible Boot Condition	Left	Flexible Bearing, Protector, & Boot	C-11
C-9	Flexible Bearing Protector Thickness Measurements	Left	Flexible Bearing Protector	C-12
C-10	Throat Diameter Measurements (Data Collection Only)	Left	Throat	C-13
C-11	Outer Boot Ring Char and Erosion Measurements and Flexible Boot Condition	Left	Outer Boot Ring & Flexible Boot	C-14
C-12	Nozzle Subassembly Phenolic Bondline Condition	Left	Aft Exit Cone	C-15
C-12	Nozzle Subassembly Phenolic Bondline Condition	Left	Forward Exit Cone	C-16

(Note: Clarification PFORs will be inserted after the applicable required PFOR in the Final Report and will have the same page number as the required PFOR appended by a sequential alphabetic extension.)

NOZZLE REQUIRED EVALUATION FORMS LIST (Cont.)

PFOR #	Title	Side	Joint, Part, or Location	Final Report Page Number
C-12	Nozzle Subassembly Phenolic Bondline Condition	Left	Throat	C-17
C-12	Nozzle Subassembly Phenolic Bondline Condition	Left	Aft Inlet/ Forward Nose Rings	C-18
C-12	Nozzle Subassembly Phenolic Bondline Condition	Left	Nose Cap	C-19
C-12	Nozzle Subassembly Phenolic Bondline Condition	Left	Cowl	C-20
C-12	Nozzle Subassembly Phenolic Bondline Condition	Left	Fixed Housing	C-21
C-13	Cowl Ring Phenolic (CCP) Section Condition	Left	Cowl	C-22
C-14	Forward Exit Cone Phenolic (CCP) Section Condition	Left	Forward Exit Cone	C-23
C-15	Fixed Housing Phenolic (CCP) Section Condition	Left	Fixed Housing	C-24
C-16	Throat Inlet Assembly Phenolic (CCP) Section Condition	Left	Throat	C-25
C-17	Nose Cap Phenolic (CCP) Section Condition	Left	Nose Cap	C-26
C-18	Forward Nose Ring and Aft Inlet Ring Phenolic (CCP) Section Condition	Left	Forward Nose & Aft Inlet Rings	C-27
C-1	Nozzle Assembly Quick-look Condition	Right	N/A	C-28
C-2	Internal Nozzle Joint Condition	Right	Joint #2	C-29
C-3	Nose Inlet-to-Flex Bearing-to-Cowl Joint Condition Drawing Worksheet	Right	Joint #2	C-30
C-2	Internal Nozzle Joint Condition	Right	Joint #3	C-31
C-4	Nose Inlet-to-Throat Joint Condition Drawing Worksheet	Right	Joint #3	C-32

(Note: Clarification PFORs will be inserted after the applicable required PFOR in the Final Report and will have the same page number as the required PFOR appended by a sequential alphabetic extension.)

NOZZLE REQUIRED EVALUATION FORMS LIST (Cont.)

PFOR #	Title	Side	Joint, Part, or Location	Final Report Page Number
C-2	Internal Nozzle Joint Condition	Right	Joint #4	C-33
C-5	Throat-to-Forward Exit Cone Joint Condition Drawing Worksheet	Right	Joint #4	C-34
C-2	Internal Nozzle Joint Condition	Right	Joint #5	C-35
C-6	Aft End Ring-to-Fixed Housing Joint Condition Drawing Worksheet	Right	Joint #5	C-36
C-7	Cowl Insulation Segment Condition	Right	Cowl	C-37
C-8	Flexible Bearing, Flexible Bearing Protector, and Flexible Boot Condition	Right	Flexible Bearing, Protector, & Boot	C-38
C-9	Flexible Bearing Protector Thickness Measurements	Right	Flexible Bearing Protector	C-39
C-10	Throat Diameter Measurements (Data Collection Only)	Right	Throat	C-40
C-11	Outer Boot Ring Char and Erosion Measurements and Flexible Boot Condition	Right	Outer Boot Ring & Flexible Boot	C-41
C-12	Nozzle Subassembly Phenolic Bondline Condition	Right	Aft Exit Cone	C-42
C-12	Nozzle Subassembly Phenolic Bondline Condition	Right	Forward Exit Cone	C-43
C-12	Nozzle Subassembly Phenolic Bondline Condition	Right	Throat	C-44
C-12	Nozzle Subassembly Phenolic Bondline Condition	Right	Aft Inlet/ Forward Nose Rings	C-45
C-12	Nozzle Subassembly Phenolic Bondline Condition	Right	Nose Cap	C-46
C-12	Nozzle Subassembly Phenolic Bondline Condition	Right	Cowl	C-47
C-12	Nozzle Subassembly Phenolic Bondline Condition	Right	Fixed Housing	C-48

(Note: Clarification PFORs will be inserted after the applicable required PFOR in the Final Report and will have the same page number as the required PFOR appended by a sequential alphabetic extension.)

NOZZLE REQUIRED EVALUATION FORMS LIST (Cont.)

PFOR #	Title	Side	Joint, Part, or Location	Final Report Page Number
C-13	Cowl Ring Phenolic (CCP) Section Condition	Right	Cowl	C-49
C-14	Forward Exit Cone Phenolic (CCP) Section Condition	Right	Forward Exit Cone	C-50
C-15	Fixed Housing Phenolic (CCP) Section Condition	Right	Fixed Housing	C-51
C-16	Throat Inlet Assembly Phenolic (CCP) Section Condition	Right	Throat	C-52
C-17	Nose Cap Phenolic (CCP) Section Condition	Right	Nose Cap	C-53
C-18	Forward Nose Ring and Aft Inlet Ring Phenolic (CCP) Section Condition	Right	Forward Nose & Aft Inlet Rings	C-54

(Note: Clarification PFORs will be inserted after the applicable required PFOR in the Final Report and will have the same page number as the required PFOR appended by a sequential alphabetic extension.)

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-1
Nozzle Assembly Quick-look Condition

Motor No.: 360L029	Side: Left (A)	Date: 1/25/95
Assessment Engineer(s)/Inspector(s): C Quick		

Nozzle Assembly Quick-look Observations:

	Yes	No	Comment #
A. Metal Damage Due to Transportation or Handling?		✓	
B. Phenolic Damage Due to Transportation or Handling?		✓	
C. Foreign Material?		✓	

Notes / Comments

[illegible] SCRAPE MARK ON OD OF FIXED HSG FLANGE FROM
[illegible] 300° - 305°
[illegible] NOZZLE MOVEMENT ON CHALKS
[illegible] FIGURES IN [illegible]
NOZZLE DOUBLE WRAPPED IN PLASTIC

Preliminary PFAR(s)? _____ Yes ✓ No   Preliminary PFAR Number(s): __________

Clarification Form(s)? _____ Yes ✓ No   Clarification Form Page No.(s): __________

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-2
Internal Nozzle Joint Condition

Motor No.: 360L029	Side: Left (A)	Date: 1/28/93

Assessment Engineer(s)/Inspector(s): R. Quick T. Freston

Joint: Nose Inlet-to-Flex Bearing-to-Cowl (Joint #2)

Internal Nozzle Joint Observations:

	Yes	No	Comment #
A. Gas Penetration in the RTV (Terminated, Through)?	✓		1
B. RTV Not Below Char Line?		✓	
C. RTV To the Primary O-ring?		✓	
D. RTV Past the Primary O-ring?		✓	
E. Uncured RTV?		✓	
F. Voids Within RTV?		✓	
G. Foreign Material?		✓	
H. Heat Affected or Eroded Virgin CCP, GCP/SCP, or adhesive?		✓	
I. Damaged Phenolics?			
J. Bondline Edge Separations? Use Clarification Form.		✓	
K. Phenolics Axially Displaced From Housing?		✓	
L. Heat Affected Metal?		✓	
M. Unbonded or Blistered Paint?		✓	
N. Corrosion?	✓		SEE PG C-3
O. Excessive Grease in Threaded Bolt Holes?			
P. Bolt Hole Damage (Through, Threaded/Helical Coil Insert)?		✓	
Q. Bent or Broken Bolts?		✓	
R. Metal Damage (Joints or Housings)?		✓	

Notes / Comments

1- GAS PATH TERMINATED AT NOSE INLET HSG/FWD END RING AT 310° SOOT EXTEND TO PRIMARY O-RING

iminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-3

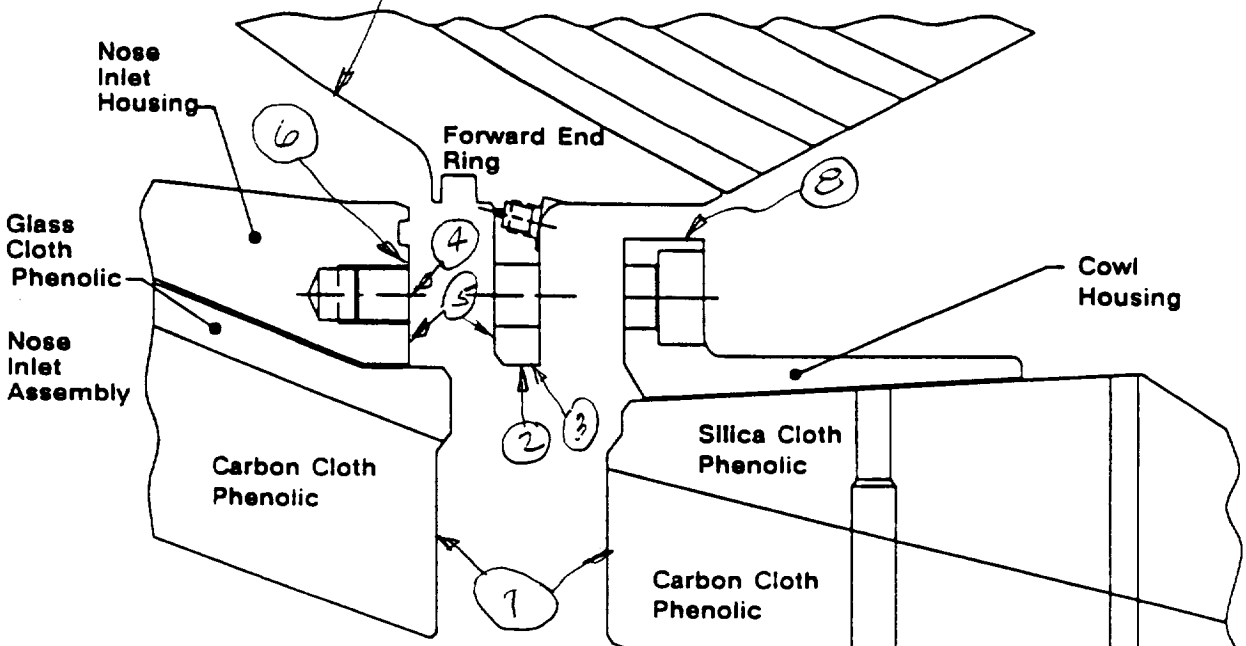
Nose Inlet-to-Flex Bearing-to-Cowl Joint (Joint #2) Condition Drawing Worksheet

Motor No.: 360L029	Side: Left (A)	Date: 1/28/93
Assessment Engineer(s)/Inspector(s): R. QUICK T. FREESTON		

Sketch Observations Below (include locations and sizes of sketched features): (OD)

1-BUBBLED PAINT ON FWD FACE OF FWD END RING INTERMITTENT FROM 0°-180°

2-INTERMITTENT MISSING PAINT ON FWD FACE OF FWD END RING 360°



3-SOOT ON OD BRG FLANGE AT 310°

4-NO EXCESS GREASE IN [illegible]

5-GREASE COVERAGE WAS NOMINAL

6-SOOT ON AFT FACE OF NOSE INLET HOUSING SEE PG B-12

7-TYPICAL RTV & EA913 INTERMIXING SOOT

8-LIGHT CORROSION CORROSION INTERMITTENT 360°

..ification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-2

Internal Nozzle Joint Condition

Motor No.: 360L029	Side: Left (A)	Date: 1-28-93
Assessment Engineer(s)/Inspector(s): L.E. WILKES / T. FRESTON		
Joint: Nose Inlet-to-Throat (Joint #3)		

Internal Nozzle Joint Observations:	Yes	No	Comment #
A. Gas Penetration in the RTV (Terminated, Through)?		✓	
B. RTV Not Below Char Line?		✓	
C. RTV To the Primary O-ring?		✓	
D. RTV Past the Primary O-ring?		✓	
E. Uncured RTV?		✓	
F. Voids Within RTV?		✓	
G. Grease Inhibiting RTV Backfill?		✓	
H. Foreign Material?		✓	
I. Heat Affected or Eroded Virgin CCP, GCP/SCP, or adhesive?		✓	
J. Damaged Phenolics?		✓	
K. Bondline Edge Separations? Use Clarification Form.	✓		1
L. Phenolics Axially Displaced From Housing?		✓	
M. Heat Affected Metal?		✓	
N. Unbonded or Blistered Paint?		✓	
O. Corrosion?	✓		2
P. Alignment Pin Damage?		✓	3
Q. Excessive Grease in Threaded Bolt Holes?		✓ N/A	
R. Bolt Hole Damage (Through, Threaded/Helical Coil Insert)?		✓	
S. Bent or Broken Bolts?		✓	
T. Metal Damage (Joints or Housings)?		✓	

Notes / Comments (1) SEE PFOR CLARIFICATION FORM PAGE C-4A

(2) TYPICAL LIGHT-TO-MEDIUM CORROSION AT METAL-TO-ADHESIVE INTERFACE AROUND FULL CIRCUMFERENCE ON THROAT & NOZZLE ASSYS.

(3) NO ALIGNMENT PIN DAMAGE OR PIN HOLE DAMAGE ON THROAT HOUSING OR FORWARD END RING.

ORIGINAL PAGE IS OF POOR QUALITY

minary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ✓ Yes ____ No Clarification Form Page No.(s): C-4A

Nozzle Interface Separation Clarification Form

Motor No.: 360L029	Side: ☒ Left (A) ☐ Right (B)	Date: 1-28-93

Assessment Engineer(s)/Inspector(s): L.E. WILKES / T. FRESTON

Part:
- ☐ Forward Exit Cone (Forward End)
- ☐ Throat Ring (Aft End)
- ☒ Throat Inlet Ring (Forward End)
- ☐ Aft Inlet Ring (Aft End)
- ☐ Nose Cap (Aft End)
- ☐ Cowl (Forward End)*
- ☐ Inner Boot Ring (Forward End)

Interface Separation Types:

A. Metal-to-Adhesive
B. Within Adhesive
C. Adhesive-to-GCP
D. Within GCP
E. GCP-to-CCP
F. Within CCP
*G. Adhesive-to-SCP
*H. Within SCP
*I. SCP-to-CCP

Circumferential Location	Separation Type	Maximum Radial Width
15-82	F	.030
130-161	A	.015
190-200	A	.005

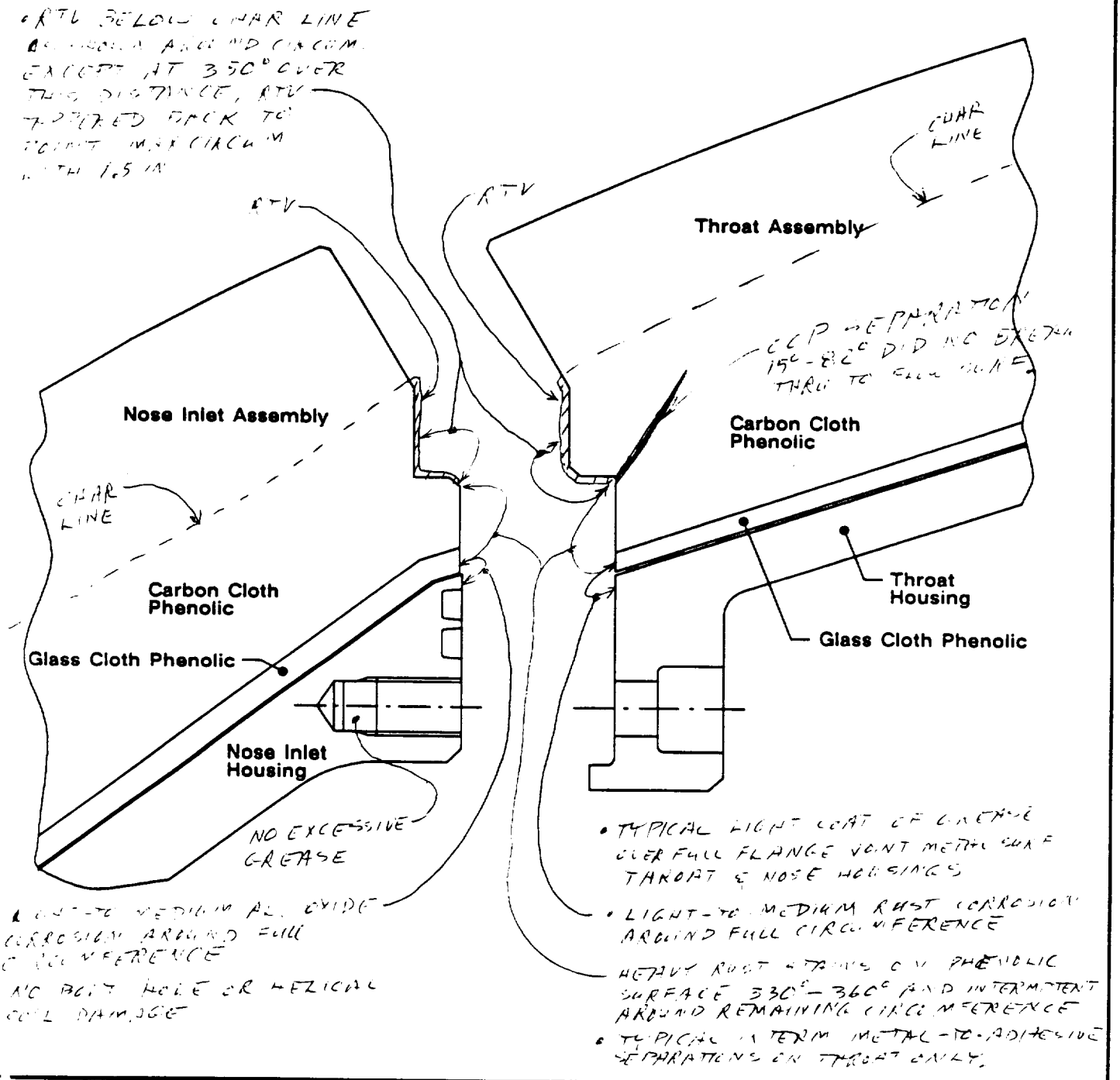
Corresponding Comment Number(s): 1

POSTFLIGHT OBSERVATION RECORD (PFOR) C-4

Nose Inlet-to-Throat Joint (Joint #3) Condition Drawing Worksheet

Motor No.: 360L029	Side: Left (A)	Date: 1-28-93
Assessment Engineer(s)/Inspector(s): L.E. WILKES		

Sketch Observations Below (include locations and sizes of sketched features):



ification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-2
Internal Nozzle Joint Condition

Motor No.: 360L029	Side: Left (A)	Date: 1/26/93
Assessment Engineer(s)/Inspector(s): R. QUICK		
Joint: Throat-to-Forward Exit Cone (Joint #4)		

Internal Nozzle Joint Observations:	Yes	No	Comment #
A. Gas Penetration in the RTV (Terminated, Through)?		✓	
B. RTV Not Below Char Line?		✓	
C. RTV To the Primary O-ring?	✓		SEE PG 7
D. RTV Past the Primary O-ring?		✓	
E. Uncured RTV?		✓	
F. Voids Within RTV?		✓	
G. Grease Inhibiting RTV Backfill?		✓	
H. Foreign Material?		✓	
I. Heat Affected or Eroded Virgin CCP, GCP/SCP, or adhesive?		✓	
J. Damaged Phenolics?		✓	
K. Bondline Edge Separations? Use Clarification Form.	✓		SEE PG C-6A
L. Phenolics Axially Displaced From Housing?		✓	
M. Heat Affected Metal?		✓	
N. Unbonded or Blistered Paint?		✓	
O. Corrosion?	✓		1 =
P. Alignment Pin Damage?		✓	
Q. Excessive Grease in Threaded Bolt Holes?			
R. Bolt Hole Damage (Through, Threaded/Helical Coil Insert)?		✓	
S. Bent or Broken Bolts?		✓	
T. Metal Damage (Joints or Housings)?		✓	

Notes / Comments

[illegible] 200-290° [illegible] AND CV [illegible]
[illegible] HEAVY CORROSION IN [illegible] FULL CIRCUMFERENCE [illegible]
[illegible] THAT BONDLINE [illegible] I.D OF HSG AFT [illegible]

[illegible] OF PROGRAM QUALITY

[illegible]minary PFAR(s)? _____ Yes ___✓___ No Preliminary PFAR Number(s): _____

Clarification Form(s)? _____ Yes ___✓___ No Clarification Form Page No.(s): C-6A

Nozzle Interface Separation Clarification Form

Motor No.: 360L029	Side: ☒ Left (A) ☐ Right (B)	Date: 1/26/93

Assessment Engineer(s)/Inspector(s): R. Quick

Part:
- ☒ Forward Exit Cone (Forward End)
- ☐ Throat Ring (Aft End)
- ☐ Throat Inlet Ring (Forward End)
- ☐ Aft Inlet Ring (Aft End)
- ☐ Nose Cap (Aft End)
- ☐ Cowl (Forward End)*
- ☐ Inner Boot Ring (Forward End)

Interface Separation Types:

A. Metal-to-Adhesive
B. Within Adhesive
C. Adhesive-to-GCP
D. Within GCP
E. GCP-to-CCP
F. Within CCP
*G. Adhesive-to-SCP
*H. Within SCP
*I. SCP-to-CCP

Circumferential Location	Separation Type	Maximum Radial Width
[illegible]	A	[illegible]
[illegible]	C	[illegible]
[illegible]	C	[illegible]
[illegible]	C	[illegible]

Corresponding Comment Number(s): _____

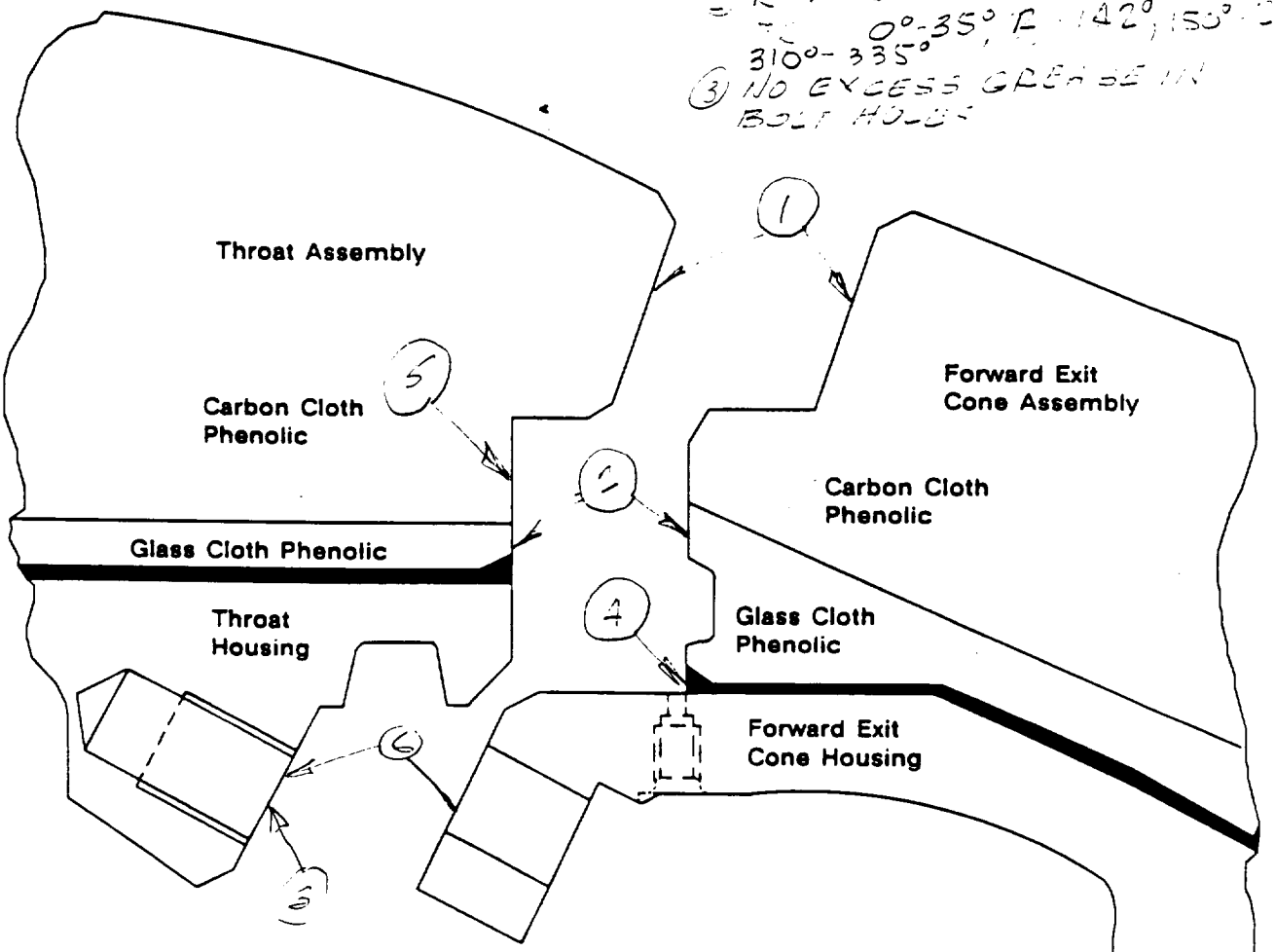
POSTFLIGHT OBSERVATION RECORD (PFOR) C-5

Throat-to-Forward Exit Cone Joint (Joint #4) Condition Drawing Worksheet

Motor No.: 360L029	Side: Left (A)	Date: 1/26/93

Assessment Engineer(s)/Inspector(s): R. Quick

Sketch Observations Below (include locations and sizes of sketched features):



DKTV BELOW CHAR LINE

0°-35°, 142°-153°, 310°-335°

③ NO EXCESS GREASE IN BOLT HOLES

④ EROSION BETWEEN PHENOLIC LINER & ADHESIVE TO 60°

⑤ PHENOLIC DISCOLORED APPEARS TO BE RUST FROM 210 THRU 5° TO 35°

⑥ GREASE COLORASS WASHOUT

Clarification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-2
Internal Nozzle Joint Condition

Motor No.: 360L029	Side: Left (A)	Date: 27 JAN 1993
Assessment Engineer(s)/Inspector(s): JIM PASSMAN, TREVOR FRESTON		
Joint: Aft End Ring-to-Fixed Housing (Joint #5)		

Internal Nozzle Joint Observations:	Yes	No	Comment #
A. Gas Penetration in the RTV (Terminated, Through)?		✓	
B. RTV Not Below Char Line?		✓	
C. RTV To the Primary O-ring?	✓		(1)
D. RTV Past the Primary O-ring?		✓	
E. Uncured RTV?		✓	
F. Voids Within RTV?	✓		(2)
G. Foreign Material?		✓	
H. Heat Affected or Eroded Virgin CCP, GCP/SCP, or adhesive?		✓	
I. Damaged Phenolics?		✓	
J. Bondline Edge Separations? Use Clarification Form.		✓	
K. Phenolics Axially Displaced From Housing?		✓	
L. Heat Affected Metal?		✓	
M. Unbonded or Blistered Paint?		✓	
N. Corrosion?	✓		(3)
O. Alignment Pin Damage?		✓	
P. Excessive Grease in Threaded Bolt Holes?		✓	
Q. Bolt Hole Damage (Through, Threaded/Helical Coil Insert)?		✓	
R. Bent or Broken Bolts?		✓	
S. Metal Damage (Joints or Housings)?		✓	

Notes / Comments

(1) RTV to PRIMARY O-RING AT 50°-107°, 225°-230°, AND 248°-285°.

(2) VOID IN RTV LOCATED AT 157°-160° 1.9" CIRC. x 0.18" WIDE.
VOID IN RTV LOCATED AT 177°-179° 1.3" CIRC. x 0.25" WIDE.
SMALL VOIDS 0.10"-0.25" DIAMETER INTERMITTENT 360°.

(3) CORROSION AS NOTED ON PFOR C-6 (PAGE C-9).

Special Issue 3.3.10 No abnormal erosion patterns or propagation of the gouges was observed

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

POSTFLIGHT OBSERVATION RECORD (PFOR) C-6

Aft End Ring-to-Fixed Housing Joint (Joint #5) Condition Drawing Worksheet

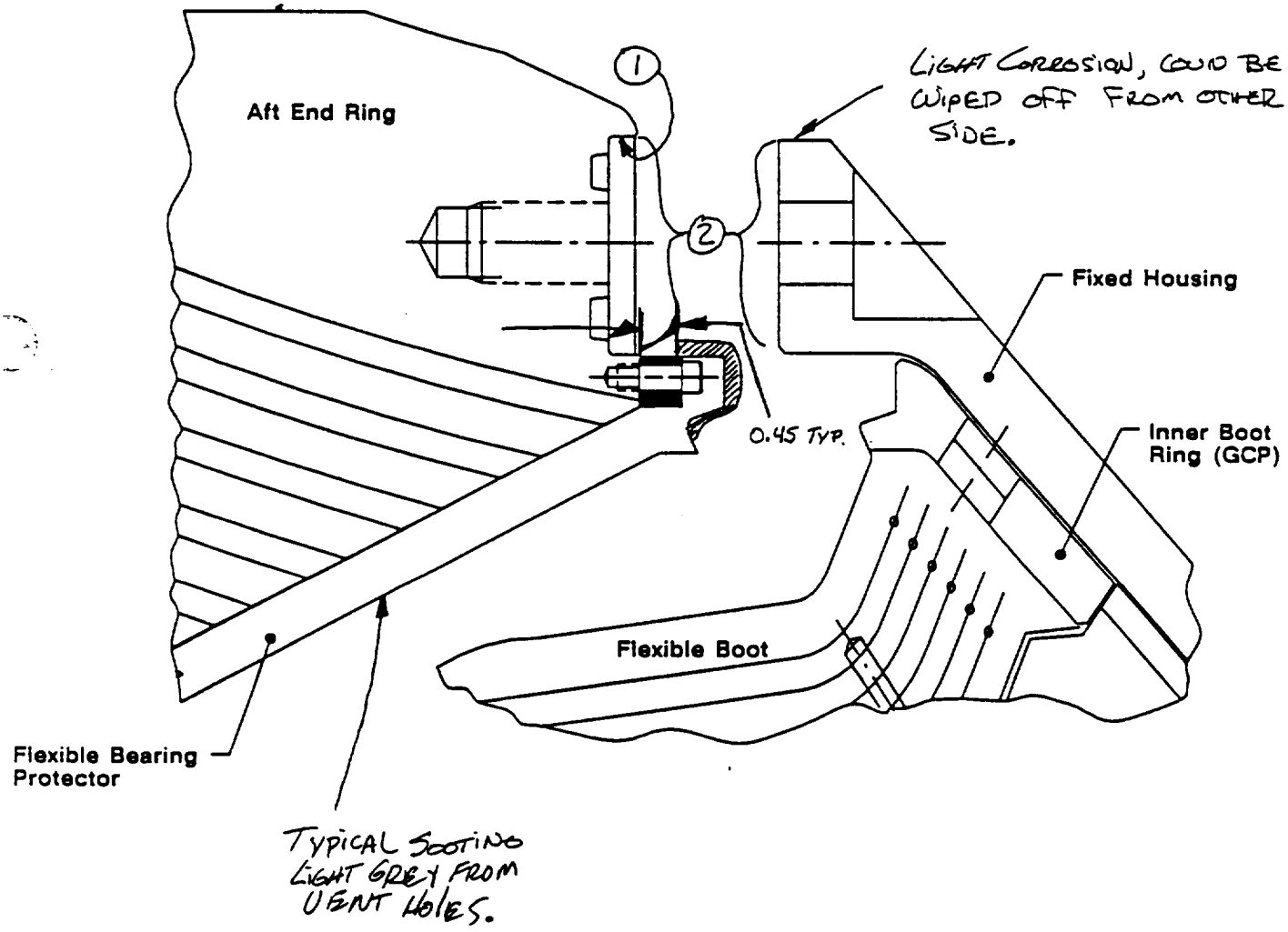
Motor No.: 360L029	Side: Left (A)	Date: 27 JAN 1993
Assessment Engineer(s)/Inspector(s): JIM PASSMAN, TREVOR PRESTON		

Sketch Observations Below (include locations and sizes of sketched features):

(1) ~~[redacted]~~ LIGHT to MEDIUM CORROSION INTERMITTENT 360°.

(2) NOMINAL GREASE COVERAGE.

(3) RTV to PRIMARY 50°-107°, 225°-230°, AND 240°-245°.



Clarification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-7
Cowl Insulation Segment Condition

Motor No.: 360L029	Side: ~~Right (B)~~ LEFT (A)	Date: 27/JAN/93

Assessment Engineer(s)/Inspector(s): PETE MILLER, L. WILKES

Cowl Insulation Segment Observations:	Yes	No	Comment #
A. Spring Pin Holes Completely Through the Cowl Segment?		✓	
B. Abnormal Heat Effects or Erosion?		✓	
C. Soot Between the Cowl Segment and Cowl Housing?		✓	
D. Bondline Failure Mode? Data Collection Only.	N/A	N/A	1

Notes / Comments

	(AM)		(AS)		(CS)	
1) 0°-45°	50%	Adhesive metal	40%	Adhesive segment	10%	cohesive segment
45°-90°	30%	" "	50%	" "	20%	" "
90-135	70%	" "	20%	" "	10%	" "
135-180	30%	" "	60%	" "	10%	" "
180-225	40%	" "	50%	" "	10%	" "
225-270	50%	" "	40%	" "	10%	" "
270-315	45%	" "	45%	" "	10%	" "
315-360	65%	" "	30%	" "	5%	" "

minary PFAR(s)? _____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

POSTFLIGHT OBSERVATION RECORD (PFOR) C-8

Flexible Bearing, Flexible Bearing Protector, and Flexible Boot Condition

Motor No.: 360L029	Side: Left (A)	Date: 27 JAN 1993

Assessment Engineer(s)/Inspector(s): JIM PASSMAN, TREVOR FRESTON, WILKES

Flexible Bearing, Bearing Protector, and Boot Observations:	Yes	No	Comment #
A. Bearing Protector Burn-Through?		✓	
B. Cracks Through the Bearing Protector?		✓	
C. Bearing Protector Heat Effects or Erosion Other Than at Cowl Vent Hole Locations?		✓	(1)
D. Soot Between the Bearing Protector and Flexible Bearing?		✓	
E. Heat Effects to the Flexible Bearing?		✓	
F. Bent or Broken Bearing Protector Bolts?		✓	(3)
G. Flexible Boot Burn-Through?		✓	
H. Abnormal Heat Effects or Erosion to Flexible Boot ID?		✓	(2)
I. Foreign Material in Boot Cavity?		✓	

Notes / Comments

(1) SMALL AREA OF EROSION ON FLEX BEARING PROTECTOR 2.8" AFT OF BELLY BAND IN LINE WITH VENT HOLE AT 50°. AREA MEASURES 3.6" CIRC. x 0.95" AXIAL WITH AN APPROXIMATE DEPTH of 0.025"-0.050". SLAG DEPOSITS WERE FOUND IN CAVITY NEXT TO BEARING PROTECTOR AND COWL INSULATION. EROSION APPEARS TO BE CAUSED BY SLAG. SIMILAR CONDITIONS HAVE BEEN FOUND ON PREVIOUS FLIGHTS.

(2) MIRROR IMAGE OF BEARING PROTECTOR EROSION FOUND ON ID OF BOOT MEASURING 3.7" CIRC. x 1.1" ~~AXIAL~~ WIDE, AND APPROX. 0.050" DEEP.

(3) FWD BEARING PROTECTOR SCREW AT 33° SHOWED SMALL (0.050 IN DIA) AREA OF BLACK CORROSION ON SIDE OF SCREW HEAD. SCREW WILL BE EVALUATED FOR POSSIBLE HEAT EFFECTS.

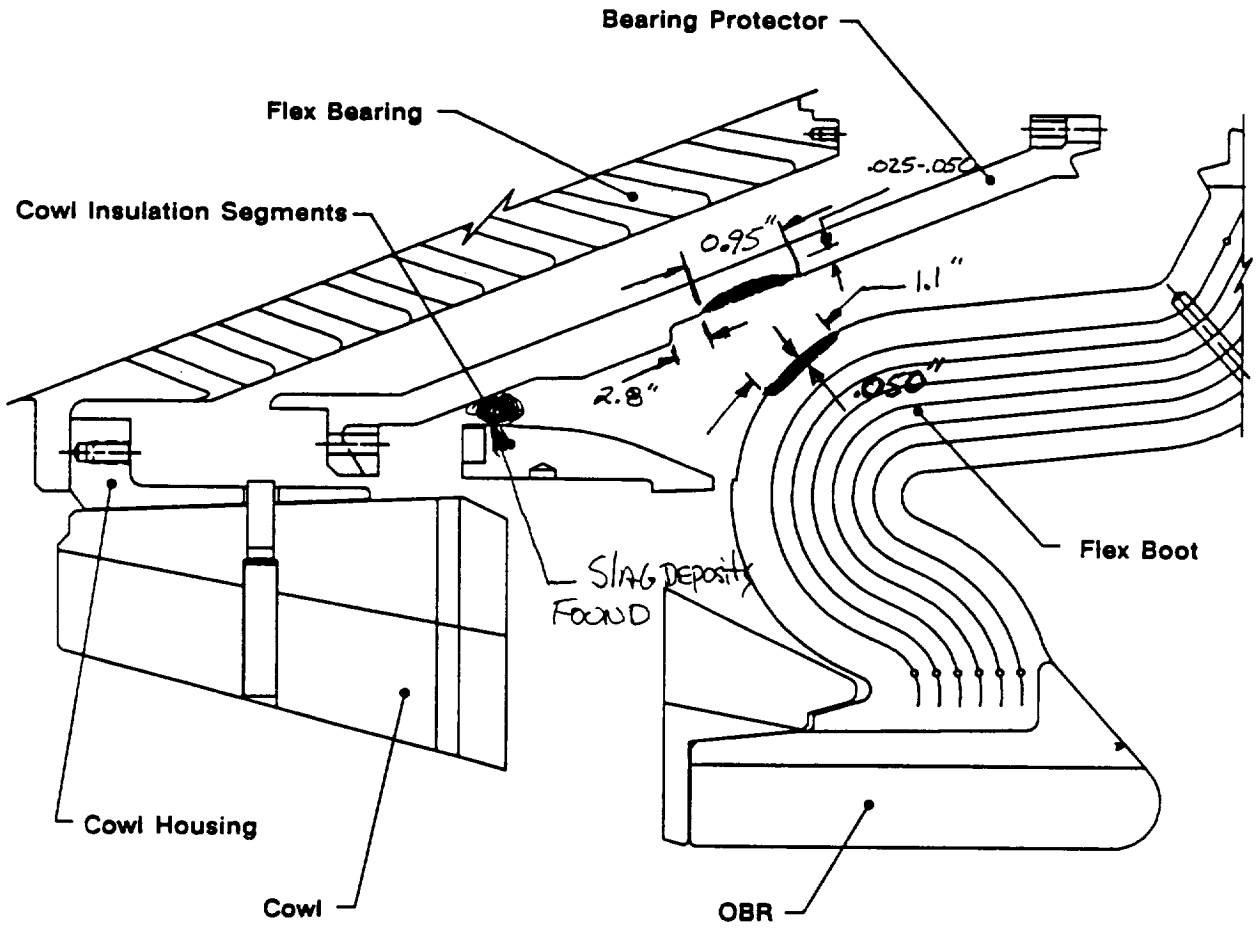
Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ✓ Yes ____ No Clarification Form Page No.(s): C/A

Flexible Boot Cavity Clarification Form

Motor No.: 360L029	Side: ☑ Left (A) ☐ Right (B)	Date: 27 JAN 1993
Assessment Engineer(s)/Inspector(s): JIM PASSMAN, TREVOR FRESTON		
Description: EROSION ON BEARING PROTECTOR AND FLEX BOOT ID AT 50° VENT HOLE		

Sketch Observations Below (include locations and sizes of sketched features):



AREA OF EROSION LOCATED DIRECTLY IN LINE WITH 50° VENT HOLE. APPEARS TO BE CAUSED BY SLAG.

NOTE: DIMENSIONS NOT TO SCALE

Corresponding Comment Number(s): (1), (2)

Thiokol CORPORATION

SPACE OPERATIONS

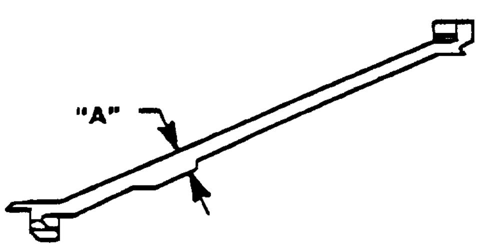
POSTFLIGHT OBSERVATION RECORD (PFOR) C-9

Flexible Bearing Protector Thickness Measurements

Motor No.: 360L029	Side: Left (A)	Date: 12-02-93
Assessment Engineer(s)/Inspector(s): P. Masterson, M. Enriquez Jr		

Record the Flexible Bearing Protector Gas Impingement Area Thickness Measurements (see figure) Below:

Degree Location	Thickness Measurement "A"* (inches)	Degree Location	Thickness Measurement "A"* (inches)	Degree Location	Thickness Measurement "A"* (inches)
0	.713	120	.715	240	.711
10	.693	130	.728	250	.697
20	.705	140	.698	260	.705
30	.694	150	.705	270	.726
40	.719	160	.696	280	.706
50	.722	170	.708	290	.726
60	.724	180	.709	300	.712
70	.698	190	.726	310	.693
80	.695	200	.724	320	.713
90	.698	210	.724	330	.692
100	.734	220	.725	340	.693
110	[illegible]	230	.718	350	.692



* "A" is the minimum thickness of the bearing protector in-line with the cowl vent holes. It corresponds to the deepest gas impingement location.

Notes / Comments

ORIGINAL PAGE IS OF POOR QUALITY

Preliminary PFAR(s)? ______ Yes ___✓___ No   Preliminary PFAR Number(s): ______

Clarification Form(s)? ______ Yes ___✓___ No   Clarification Form Page No.(s) ______

REVISION ____

DOC NO. TWR-64222 | VOL
SEC | PAGE C-12

POSTFLIGHT OBSERVATION RECORD (PFOR) C-10

Throat Diameter Measurements (Data Collection Only)

Motor No.: 360L029	Side: Left (A)	Date: 01-28-93

Assessment Engineer(s)/Inspector(s): RP GALLEGOS, JED BENSON

Record the Nozzle Throat Diameter Measurements Below:

Degree Location	Diameter Measurement (inches)
0	55.977"
45	56.000"
90	55.935"
135	56.000"

Notes / Comments

SL-45062

C ..ication Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

POSTFLIGHT OBSERVATION RECORD (PFOR) C-11

Outer Boot Ring Char and Erosion Measurements and Flexible Boot Condition

Motor No.: 360L029	Side: Left (A)	Date: 3/3/93, 2-17-93

Assessment Engineer(s)/Inspector(s): Jim PASSMAN, MARK CLARK

Flexible Boot/Outer Boot Ring Separation Observations:

	Yes	No	Comment #
A. Heat Effects in Boot/OBR Separation?	____	✓	____

Record the Outer Boot Ring Char and Erosion Measurements Below:

Station	0°		90°		180°		270°	
Location	Erosion	Char	Erosion	Char	Erosion	Char	Erosion	Char
8.0	0.08	0.94	—	1.01*	0.08	0.96	—	0.96*
9.0	0.09	0.91	0.12	0.83	0.09	0.88	—	0.88*
10.0	0.15	0.88	0.09	0.87	0.12	0.86	0.06	0.80
11.3	0.24	0.82	0.07	0.94	0.16	0.95	.08	0.82

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Record the Number of Plies Remaining on the Flexible Boot:

Degree Location	Plies Remaining
0	3.7
90	3.3
180	3.9
270	3.4

Negative Margin of Safety? ____ Yes ✓ No Degree: ____

Notes / Comments * TOTAL (CHAR AND EROSION)

Special Issue 3.3.10 No abnormal erosion patterns or propagation observed [illegible] separation within boot plies

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Left (A)	Date: 2-4-93

Assessment Engineer(s)/Inspector(s): WILKES / TELLERS / J. PASSMAN / P MILLER

Phenolic Subassembly: Aft Exit Cone Assembly

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location							
	45-135	135-225	225-315	315-45				
Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-GCP								
Within GCP	100	100	100	100				
GCP-to-CCP								
Within CCP								

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

	Degree Location							
Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-GCP	100	100	100	100				

Phenolic Removal Method: HAMMER, WEDGE & PEEL, MUCH WORK.

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?		✓	
C. Corrosion?		✓	
D. Foreign Material?		✓	
E. Voids in Polysulfide (Aft Exit Cone Polysulfide Groove)?	✓		(1)

Notes / Comments

(1) VOIDS INTERMITTENT ON INBOARD SURFACE; TYPICAL SIZE 0.05" - 0.10" DIA.

iminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Left (A)	Date: 1-29-93
Assessment Engineer(s)/Inspector(s): WILKES/FRESTON/LA[illegible]E/SIMMONS/[illegible]		
Phenolic Subassembly: Forward Exit Cone Assembly		

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

SEE NOTE 1

	Degree Location							
	0-90	90-180	180-270	270-360				total
Metal-to-Adhesive	15	10	15	15				14
Within Adhesive	10	10	10	10				1
Adhesive-to-GCP	75	80	75	75				76
Within GCP								
GCP-to-CCP								
Within CCP								

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

N/A.

	Degree Location							
Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-GCP								

Phenolic Removal Method: _____

Metal Housing Bondline Surface Observations:

	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		2
C. Corrosion?	✓		3
D. Foreign Material?		✓	

Notes / Comments (1) SEE CLARIFICATION FORM PAGE C-16A FOR DEVIATIONS FROM NOMINAL PHENOLIC LINER REMOVAL PROCEDURES.
(2) SEE NEXT CLARIFICATION FORM PAGE C-16B.
(3) TYPICAL MED.-TO-HEAVY CORROSION BETWEEN 6-TO-10 INCHES OF FWD END AROUND 75% OF CIRCUMFERENCE AND 0-8 INCHES INTERMITTENTLY AROUND [illegible]% OF CIRCUMFERENCE AND AROUND ALL SHEAR PIN HOLES FWD & AFT. (at aft end)

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? ✓ Yes ____ No Clarification Form Page No.(s) C-16A & B

General Hardware Clarification Form

Motor No.: 360L029	Side: ☑ Left (A) ☐ Right (B)	Date: 1-29-93

Assessment Engineer(s)/Inspector(s): WILKES/FREESTONE/LANGE/SIMMONS/MILLER

Description: PHENOLIC BONDLINE CONDITION, FWD EXIT CONE ASSEMBLY

Sketch Observations Below (include locations and sizes of sketched features):

THE NOMINAL PROCESSING OF PHENOLIC REMOVAL IS TO WATER-JET CUT 4 PLACES 90° APART OVER FULL AXIAL LENGTH THROUGH TO CC TO METAL SURFACE. NYLON WEDGES ARE THEN DRIVEN, USING PLASTIC HAMMERS, BETWEEN THE METAL AND AD-CASE. THE PRIMARY BOND FAILURE MODE IS DETERMINED FROM REMAINING PHENOLIC ON ADHESIVE.

THE AS-IN-29A NOZZLE FORWARD EXIT CONE HAD TEN AXIAL CCP LINER REMAINING ON THE FORWARD END, ARCING FULL CIRCUMFERENCE AND UP TO EIGHT INCHES MAXIMUM WIDE AT ALL, FROM 160° TO 330°. THE REMAINING MIDDLE SECTION SHOWED CCP-TO-GCP SEPARATIONS. AN AXIAL SAW CUT WAS MADE THROUGH THE CCP TO GCP INTERFACE. NYLON WEDGES WERE DRIVEN BETWEEN THE CCP AND GCP. THE AFT CCP FRAGMENT SEPARATED AT CCP/GCP INTERFACE. THE FWD FRAGMENT AFT HALF, UP TO SHEAR SCARPS, REMAINED AT CCP-TO-GCP INTERFACE. THE REMAINING FWD FRAGMENT, FROM SHEAR SCARPS FWD, SEPARATED 85% ADHESIVE-TO-GCP, 10% METAL-TO-ADHESIVE AND 5% WITHIN ADHESIVE. 50% OF THE METAL-TO-ADHESIVE WAS FROM PATCHES AROUND 75% OF THE SHEAR PIN HOLES. LARGEST PATCH WAS 2.0 IN DIAMETER.

Corresponding Comment Number(s): 1

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☑ Left (A) ☐ Right (B)	Date: 2-2-93
Assessment Engineer(s)/Inspector(s): WILKES / MILLER		
Nozzle Subassembly: FWD EXIT CONE		

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size Axial	Void Size Circ.	Location on Bonding Surface Distance From Fwd	Location on Bonding Surface Distance From Aft
17	.70	.40		7.4
6	.90	.60		29.4
77	.60	.40		29.2
201	.50	.40		28.6

Notes / Comments ① VERY FEW SMALL ADHESIVE VOIDS WERE OBSERVED INADVERTENTLY ARCHIVED BY REFERENCE.

Corresponding Comment Number(s): 2

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Left (A)	Date: 29 JAN 1993

Assessment Engineer(s)/Inspector(s): JIM PASSMAN, TREVOR FRESTON

Phenolic Subassembly: Throat Assembly

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location							
	45°-135°	135°-225°	225°-315°	315°-45°				
Metal-to-Adhesive	100	100	100	100				
Within Adhesive								
Adhesive-to-GCP								
Within GCP								
GCP-to-CCP								
Within CCP								

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

	Degree Location							
Metal-to-Adhesive	N/A							
Within Adhesive			N/A					
Adhesive-to-GCP								

Phenolic Removal Method: _____

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		(1)
C. Corrosion?	✓		(2)
D. Foreign Material?		✓	

Notes / Comments
(1) Small Voids Typically 0.10"-0.20" DIA Located Intermittently 360°. Larger Voids Located Near the Aft End of the 225°-315° Section. Sizes and Locations are Documented of Clarification Form Page C-17A.
(2) Medium to Heavy Corrosion over Whole Housing Bondline Surface.

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? ✓ Yes ____ No Clarification Form Page No.(s): C-17A

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☑ Left (A) ☐ Right (B)	Date: 29 JAN 1993
Assessment Engineer(s)/Inspector(s): JIM PASSMAN, TREVOR FRESTON		
Nozzle Subassembly: THROAT		

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size Axial	Void Size Circ.	Location on Bonding Surface Distance From Fwd	Location on Bonding Surface Distance From Aft
240°	0.70	0.25	—	0.30
257°	0.85	0.15	—	0.15
260°	2.25	0.45	—	0.15
280°	0.60	0.40	—	0.10

Notes / Comments

Corresponding Comment Number(s): (1)

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Left (A)	Date: 2-1-[illegible]
Assessment Engineer(s)/Inspector(s): M. Clark, R. Tillers		
Phenolic Subassembly: Aft Inlet/Forward Nose Rings		

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location							
	315-45	45-135	135-225	225-315				Total
Metal-to-Adhesive	90	100	98	75				91
Within Adhesive	1			2				1
Adhesive-to-GCP	9		2	23				8
Within GCP								
GCP-to-CCP								
Within CCP								

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

	Degree Location							
Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-GCP								

Phenolic Removal Method: _____

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		1
C. Corrosion?	✓		2
D. Foreign Material?		✓	

Notes / Comments: 2) Medium Corrosion observed in areas of metal-to-adhesive separation

Special Issue 3.3.6: Adhesive void found at 78° measured 0.5" axial x 0.25" circ., 0.35" from fwd end of -503 ring

Special Issue 3.3.11: 6 voids found greater than 0.30" found see page C-18A. No Repair areas observed on housing

minary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? ✓ Yes ____ No Clarification Form Page No.(s): C-18A

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☒ Left (A) ☐ Right (B)	Date: 2-1-93
Assessment Engineer(s)/Inspector(s):	M.E. Clark	
Nozzle Subassembly:	-503 (Field Joint) Ring	

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size Axial	Void Size Circ.	Location on Bonding Surface Distance From Fwd	Location on Bonding Surface Distance From Aft
234	.1	.21	2.4	
255.5	.40	.15	0.5	
264	.40	.20	0.4	
245	.45	.20	0.8	
267	.30	.20	2.3	
79	.3	.25	0.35	

Notes / Comments

Corresponding Comment Number(s): 2

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Left (A)	Date: 2-1-93
Assessment Engineer(s)/Inspector(s): M. Clark, K. Tellers		
Phenolic Subassembly: Nose Cap		

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location							
	315-45	45-135	135-225	225-315				TOTAL
* Metal-to-Adhesive	3	2	1	1				2
Within Adhesive								
Adhesive-to-GCP								
Within GCP	1	1	1	1				1
GCP-to-CCP	96	97	99	98				97
Within CCP								

* on fwd inner only

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

	Degree Location							
	315-45	45-135	135-225	225-315				TOTAL
Metal-to-Adhesive	30	40	25	20				29
Within Adhesive								
Adhesive-to-GCP	90	60	75	80				71

Phenolic Removal Method: Wedges & hand peel

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		1
C. Corrosion?	✓		2
D. Foreign Material?		✓	

Notes / Comments
1) Voids greater than 0.5" diameter found
2) Medium Corrosion in areas of metal-to-adhesive separations aft 1.0"-2.0" and aft 3.0"-4.0"

Special Issue 3.3.3 Design of LDI found

Special Issue 3.3.11 2 voids greater than 0.3" found see page C-11H
No repair areas observed on housing

Preliminary PFAR(s)? ✓ Yes ____ No Preliminary PFAR Number(s): 54C-01

Clarification Form(s)? ✓ Yes ____ No Clarification Form Page No.(s): C-11H

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☒ Left (A) ☐ Right (B)	Date: 2-1-13
Assessment Engineer(s)/Inspector(s):	M. Clark, R. Tellers	
Nozzle Subassembly:	Nose Cap	

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size Axial	Void Size Circ.	Location on Bonding Surface Distance From Fwd	Location on Bonding Surface Distance From Aft
74.5	.40	.20		.25
271	.25	.15	4.80	

Notes / Comments

Corresponding Comment Number(s): 2

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Left (A)	Date: 1-28-93

Assessment Engineer(s)/Inspector(s): WILKES / TELLEFS

Phenolic Subassembly: Cowl Assembly

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

Degree Location

	0-360							
Metal-to-Adhesive	99							
Within Adhesive								
Adhesive-to-SCP	1 *							
Within SCP								
SCP-to-CCP								
Within CCP								

* AROUND SPRING PINS ONLY

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

N/R.

Degree Location

Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-SCP								

Phenolic Removal Method: ______

Metal Housing Bondline Surface Observations:

	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		1
C. Corrosion?	✓		2
D. Foreign Material?		✓	

ORIGINAL PAGE IS OF POOR QUALITY

Notes / Comments ① SEE PFOR CLARIFICATION FORM PAGE C-20A & B.
② LIGHT-TO-MEDIUM AL. OXIDE CORROSION THROUGHOUT LENGTH & CIRCUMFERENCE [illegible] OF BOND SURFACE.

Special Issue 3.3.11
NO RESIN [illegible] AREAS WERE OBSERVED ON COWL HOUSING.
SEE PAGE C-20 A & B FOR VOIDS
③ [illegible] LAYER OF [illegible] SQUEEZED BETWEEN METAL HOUSING AND [illegible] UP TO [illegible] FROM FWD END [illegible] AT 232°-310° AND 16 OTHER PLACES [illegible] VERY SMALL. NO ADHESIVE VOIDS WERE OBSERVED IN THESE AREAS.

Preliminary PFAR(s)? ____ Yes ✓ No   Preliminary PFAR Number(s): ______

Clarification Form(s)? ✓ Yes ____ No   Clarification Form Page No.(s): C-20A, B

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☑ Left (A) ☐ Right (B)	Date: 1-28-93
Assessment Engineer(s)/Inspector(s): WILKES / TELLERS		
Nozzle Subassembly: COWL		

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size		Location on Bonding Surface	
	Axial	Circ.	Distance From Fwd CHAM EDGE	Distance From Aft
[illegible]	0.30	0.10	1.65	
138	0.30	0.15	2.20	
141	0.10	0.55	0.35	
166°-167°	0.30	3.95	0.00	
164	0.30	0.15	1.10	
167	0.40	0.15	1.10	
167.5	0.30	0.15	1.20	
162	.30	.10	2.45	
173	.40	.10	0.00	
[illegible]	.40	.10	0.00	
172-176	.25	1.50	.40	
174	.45	.10	0.00	
177	.30	.20	1.65	

Notes / Comments MANY SMALL ADHESIVE VOIDS, 0.25 IN. DIA MAX., WERE OBSERVED FROM 140° TO 220°. VERY FEW VOIDS WERE OBSERVED ACROSS REMAINDER CIRCUMFERENCE.

Corresponding Comment Number(s): 1

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☑ Left (A) ☐ Right (B)	Date: 1-28-93
Assessment Engineer(s)/Inspector(s): WILKES / TELLEY'S		
Nozzle Subassembly: COWL		

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size		Location on Bonding Surface	
	Axial	Circ.	Distance From Fwd	Distance From Aft
1F1	.30	.10	.95	
1F2-1B2	.45	1.20	2.20	
1B4	.30	.25	1.95	
1B6	.30	.30	1.95	
1B8	.35	.20	1.65	
1B2	.35	.05	0.10	
1B2-1B4	.20	1.10	.25	
1B° 201	.30	2.0	.20	
201	.25	.70	0.00	
201	.45	.20	0.50	
[illegible]	0.10	.35	3.00	

Notes / Comments

Corresponding Comment Number(s): 1

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Left (A)	Date: 2 FEB 93

Assessment Engineer(s)/Inspector(s): R. QUICK T. FRESTON

Phenolic Subassembly: Fixed Housing Assembly

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location								
	0-45	45-90	90-135	135-180	180-225	225-270	270-315	315-0	
Metal-to-Adhesive	50%	97%	30%	90%	70%	98%	100%	100%	(1)
Within Adhesive									
Adhesive-to-GCP									
Within GCP									
GCP-to-CCP	50%	3%	70%	10%	30%	2%	0%	0%	
Within CCP									

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

	Degree Location							
	0-360							
Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-GCP	100%							

Phenolic Removal Method: _____

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		SEE PG C-21A
C. Corrosion?		✓	
D. Foreign Material?		✓	

Notes / Comments 1- 80% ADHESIVE TO METAL FAILURE OVER ENTIRE BONDLINE

Preliminary PFAR(s)? ✓ Yes ____ No Preliminary PFAR Number(s): 54C-02

Clarification Form(s)? ✓ Yes ____ No Clarification Form Page No.(s): C-21A

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☒ Left (A) ☐ Right (B)	Date: 2 FEB 93
Assessment Engineer(s)/Inspector(s): R. Quick T. Feeston		
Nozzle Subassembly: FIXED HOUSING ASSEMBLY		

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size Axial	Void Size Circ.	Location on Bonding Surface Distance From Fwd	Location on Bonding Surface Distance From Aft
104	.48	.28 overall .55	4.75	
257	1.42	.31		11.45
260	.40	.53		5.62
280	.96	.20		4.85
295	.47	.25		14.10
65	.53	.35		8.10
98	.97	.40		1.05
101	1.10	.27		1.80
120	.30	.50		1.70

Notes / Comments

Corresponding Comment Number(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-13
Cowl Ring Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Left (A)	Date: 5-17-93
Assessment Engineer(s)/Inspector(s): R. Quick		

Cowl Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓ ?	

Record the Cowl Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
0.3	.2[illegible]	.56	.26	.57	.30	.52	.[illegible]7	.5[illegible]
1.0	.2[illegible]	.54	.30	.55	.35	.53	.[illegible]5	.54
2.0	.4[illegible]	.56	.27	.58	.38	.54	.[illegible]7	.[illegible]
3.0	.4[illegible]	.6[illegible]	.3[illegible]	.6[illegible]	.35	.63	.[illegible]6	.61
4.0	.4[illegible]	.60	.3[illegible]	.61	.35	.66	.[illegible]	.[illegible]
5.0	.4[illegible]	.62	.3[illegible]	.[illegible]6	.36	.68	.[illegible]	.6[illegible]
6.0	.[illegible]	.10	.22	.14	.35	.79	.[illegible]5	.61
6.8	0.32	0.73	0.24	0.83	NA	NA	NA	NA

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments

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[illegible]iminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

C [illegible]rification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____ ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-14
Forward Exit Cone Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Left (A)	Date: 6-10-93

Assessment Engineer(s)/Inspector(s): M. Clark

Forward Exit Cone Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Forward Exit Cone Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
1.0	.39	.65	.40	.63	.44	.65	.41	.66
4.0	.42	.65	.41	.62	.40	.63	.39	.77
4.6	.39	.67	.37	.64	.40	.64	.43	.67
8.0	.37	.68	.32	.66	.39	.63	.32	.77
12.0	NA	NA	NA	NA	NA	NA	NA	NA
16.0	↑	↑	↑	↑	↑	↑	↑	↑
20.0								
24.0			↓	↓	NA	NA	NA	NA
28.0			NA	NA	.24	.64	.24	.69
32.0			.22	.65	.25	.56	.19	.70
32.9	↓	↓	.22	.61	.19	.62	.15	.75
34.0	NA	NA	.17	.62	.11	.69	.16	.70

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ✓ Yes ____ No Clarification Form Page No.(s): C-23A, C-23B

POSTFLIGHT OBSERVATION RECORD (PFOR) C-19

Forward Exit Cone Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: LEFT (A)	Date: 4-9-93

Assessment Engineer(s)/Inspector(s): L.E WILKES

AFT Exit Cone Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Forward Exit Cone Char and Erosion Measurements Below:

Station Location	270° Erosion	270° Char	280° Erosion	280° Char	290° Erosion	290° Char	300° Erosion	300° Char
118.77	NA	NA	NA	NA	NA	NA	NA	NA
113.77	.170	.590	.170	.540	.150	.570	.170	.540
107.77	.150	.580	.170	.520	.150	.560	.150	.570
101.77	.160	.570	.170	.550	.130	.540	.140	.550
95.77	.130	.520	NA	NA	NA	NA	NA	NA
89.77	NA	NA	↓	↓	↓	↓	↓	↓
83.77	↓	↓	↓	↓	↓	↓	↓	↓
77.77	↓	↓	↓	↓	↓	↓	↓	↓
73.77	↓	↓	↓	↓	↓	↓	↓	↓

Negative Margin of Safety? _____ Yes ✓ No Station: _____ Degree: _____

Notes / Comments

Preliminary PFAR(s)? _____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

POSTFLIGHT OBSERVATION RECORD (PFOR) C-19

Forward Exit Cone Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: LEFT (A)	Date: 4-9-93

Assessment Engineer(s)/Inspector(s): L. E. WILKES

AFT Exit Cone Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Forward Exit Cone Char and Erosion Measurements Below:

Station Location	310° Erosion	310° Char	Erosion	Char	Erosion	Char	Erosion	Char
118.77	NA	NA						
113.77	.240	.570						
107.77	.130	.670						
101.77	.130	.610						
95.77	NA	NA						
89.77	↓	↓						
83.77								
77.77								
73.77	↓	↓						

Negative Margin of Safety? _____ Yes ✓ No Station: _____ Degree: _____

Notes / Comments

Preliminary PFAR(s)? _____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-15
Fixed Housing Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Left (A)	Date: 6-10-93
Assessment Engineer(s)/Inspector(s): M. Clark		

Fixed Housing Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Fixed Housing Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
0.0	0	1.13	.14	1.30	.07	1.42	[illegible]	1.19
1.0	[illegible]	[illegible]	.07	1.02	.08	1.61	0	.91
2.0	[illegible]	.85	[illegible]	.90	[illegible]	.37	[illegible]	1.06
3.0	[illegible]	.83	[illegible]	.65	[illegible]	.87	0	1.01
4.0	[illegible]	.78	[illegible]	.63	.09	.90	[illegible]	.97
5.0	[illegible]	.87	[illegible]	.64	[illegible]	.74	[illegible]	[illegible]
6.0	[illegible]	.88	[illegible]	.60	.04	.86	[illegible]	[illegible]
7.0	[illegible]	.90	[illegible]	.55	[illegible]	.88	[illegible]	[illegible]
8.0	[illegible]	[illegible]	[illegible]	.45	[illegible]	.83	[illegible]	.72
9.0	[illegible]	1.63	[illegible]	.64	[illegible]	.90	[illegible]	1.0
10.75	[illegible]	1.91	[illegible]	1.66	.15	1.77	[illegible]	1.92

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments

...liminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

...rication Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-16
Throat Inlet Assembly Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Left (A)	Date: 3/3/93

Assessment Engineer(s)/Inspector(s): Jim PASSMAN, Carry Wilks

Throat Inlet Assembly Phenolic Section Observations:	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Throat Inlet Ring and Throat Ring Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
1.0	1.09	0.59	1.08	0.59	1.06	0.47	1.06	0.58
2.0	1.14	0.57	1.09	0.58	1.09	0.54	1.09	0.59
4.0	1.17	0.60	1.14	0.62	1.16	0.57	1.16	0.57
6.0	1.21	0.67	1.19	0.60	1.19	0.62	1.23	0.57
8.0	1.29	0.56	1.22	0.58	1.26	0.47	1.28	0.51
10.0	1.24	0.55	1.19	0.46	1.21	0.48	1.21	0.54
12.0	1.20	0.57	1.13	0.46	1.18	0.54	1.18	0.59
14.0	1.20	0.53	1.10	0.48	1.17	0.53	1.18	0.51
16.0	1.14	0.57	1.04	0.48	1.06	0.57	1.10	0.53
18.0	0.99	0.56	0.91	0.55	0.92	0.66	0.98	0.62
20.0	0.77	0.62	0.68	0.66	0.76	0.61	0.74	0.63
22.0	0.57	0.71	0.48	0.73	0.53	0.77	0.53	0.68
23.0	0.45	0.77	0.43	0.76	0.43	0.71	0.48	0.66

Negative Margin of Safety? _____ Yes ✓ No Station: _____ Degree: _____

Notes / Comments

Preliminary PFAR(s)? _____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

POSTFLIGHT OBSERVATION RECORD (PFOR) C-17

Nose Cap Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Left (A)	Date: 3/3/93

Assessment Engineer(s)/Inspector(s): Jim PASSMAN, CAROL WILKES

Nose Cap Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Nose Cap Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
1.5	NA	NA	NA	NA	NA	NA	NA	NA
4.0	0.42	0.48	0.34	0.56	0.32	0.54	0.39	0.52
6.0	0.41	0.53	0.35	0.55	0.32	0.52	0.41	0.57
8.0	0.47	0.56	0.42	0.50	0.39	0.53	0.43	0.51
10.0	0.49	0.54	0.44	0.46	0.41	0.55	0.47	0.47
12.0	0.59	0.52	0.47	0.49	0.51	0.49	0.55	0.46
14.0	0.67	0.45	0.49	0.48	0.53	0.47	0.59	0.43
16.0	0.76	0.47	0.60	0.47	0.63	0.45	0.70	0.42
18.0	0.94	0.52	0.74	0.36	0.81	0.47	0.88	0.50
20.0	1.23	0.50	1.08	0.33	0.99	0.45	1.07	0.49
22.0	1.78	0.64	1.54	0.63	1.37	0.61	1.61	0.74
24.0	1.92	0.67	1.68	0.71	1.54	0.72	1.83	0.65
26.0	1.36	0.64	1.18	0.74	1.08	0.76	1.29	0.70

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-18

Forward Nose Ring and Aft Inlet Ring Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Left (A)	Date: 3/3/93
Assessment Engineer(s)/Inspector(s): Jim Fassman, Larry Wiks		

Forward Nose and Aft Inlet Ring Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Forward Nose Ring (-503) Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
28.0	1.15	0.68	1.07	0.68	1.04	0.74	1.18	0.65
30.0	0.94	0.69	0.91	0.78	0.87	0.69	0.96	0.69
32.0	0.95	0.61	0.90	0.71	0.89	0.68	1.00	0.61

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Record the Aft Inlet Ring Char (-504) and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
34.0	0.87	0.57	0.84	0.62	0.82	0.56	0.90	0.50
36.0	0.91	0.59	0.89	0.57	0.87	0.56	0.95	0.56
38.0	0.98	0.64	0.95	0.57	0.94	0.53	1.01	0.56
39.0	1.04	0.66	0.98	0.63	0.96	0.62	1.03	0.65

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-1

Nozzle Assembly Quick-look Condition

Motor No.: 360L029	Side: Right (B)	Date: [illegible]
Assessment Engineer(s)/Inspector(s): [illegible]		

Nozzle Assembly Quick-look Observations:

	Yes	No	Comment #
A. Metal Damage Due to Transportation or Handling?		✓	
B. Phenolic Damage Due to Transportation or Handling?		✓	
C. Foreign Material?		✓	

Notes / Comments

[illegible]
[illegible]
[illegible] SEALED [illegible]
[illegible] SCRAP [illegible] OD OF FIXED HSG
[illegible] 240° - 305°

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[Prelimi]nary PFAR(s)? ______ Yes ✓ No Preliminary PFAR Number(s): ______

Clarification Form(s)? ______ Yes ✓ No Clarification Form Page No.(s): ______

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-2
Internal Nozzle Joint Condition

Motor No.: 360L029	Side: Right (B)	Date: 1, 23 95
Assessment Engineer(s)/Inspector(s): R. QUICK, T. FREESTON		
Joint: Nose Inlet-to-Flex Bearing-to-Cowl (Joint #2)		

Internal Nozzle Joint Observations:	Yes	No	Comment #
A. Gas Penetration in the RTV (Terminated, Through)?	/		5
B. RTV Not Below Char Line?		✓	
C. RTV To the Primary O-ring?		✓	
D. RTV Past the Primary O-ring?		✓	
E. Uncured RTV?		✓	
F. Voids Within RTV?		✓	
G. Foreign Material?			
H. Heat Affected or Eroded Virgin CCP, GCP/SCP, or adhesive?	✓		1
I. Damaged Phenolics?		✓	
J. Bondline Edge Separations? Use Clarification Form.		✓	
K. Phenolics Axially Displaced From Housing?		✓	
L. Heat Affected Metal?		✓	
M. Unbonded or Blistered Paint?		✓	
N. Corrosion?	✓		2
O. Excessive Grease in Threaded Bolt Holes?		✓	
P. Bolt Hole Damage (Through, Threaded/Helical Coil Insert)?		✓	
Q. Bent or Broken Bolts?		✓	
R. Metal Damage (Joints or Housings)?		✓	

Notes / Comments

Special Issue 3.3.2 - [illegible] LDI'S DETECTED AT NOSE INLET TO COWL [illegible]
- [illegible] HEATED RTV AT 318°, .62 INBOARD OF FLOW SURFACE
[illegible] SOOT AT ALL SCAB BURNED HOLES IN RTV, HEAT AFFECTED CORK
TERMINATED AT 713 ON OD CHAMFER OF COWL HSG.
2 - SEE COMMENT #5 ON PG B-51

3 - GAS PATH IN RTV AT 552° AND TERMINATED AT CHAMFER OF COWL
ASSY, RTV & EROSION BUILD UP)

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OF POOR QUALITY

minary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

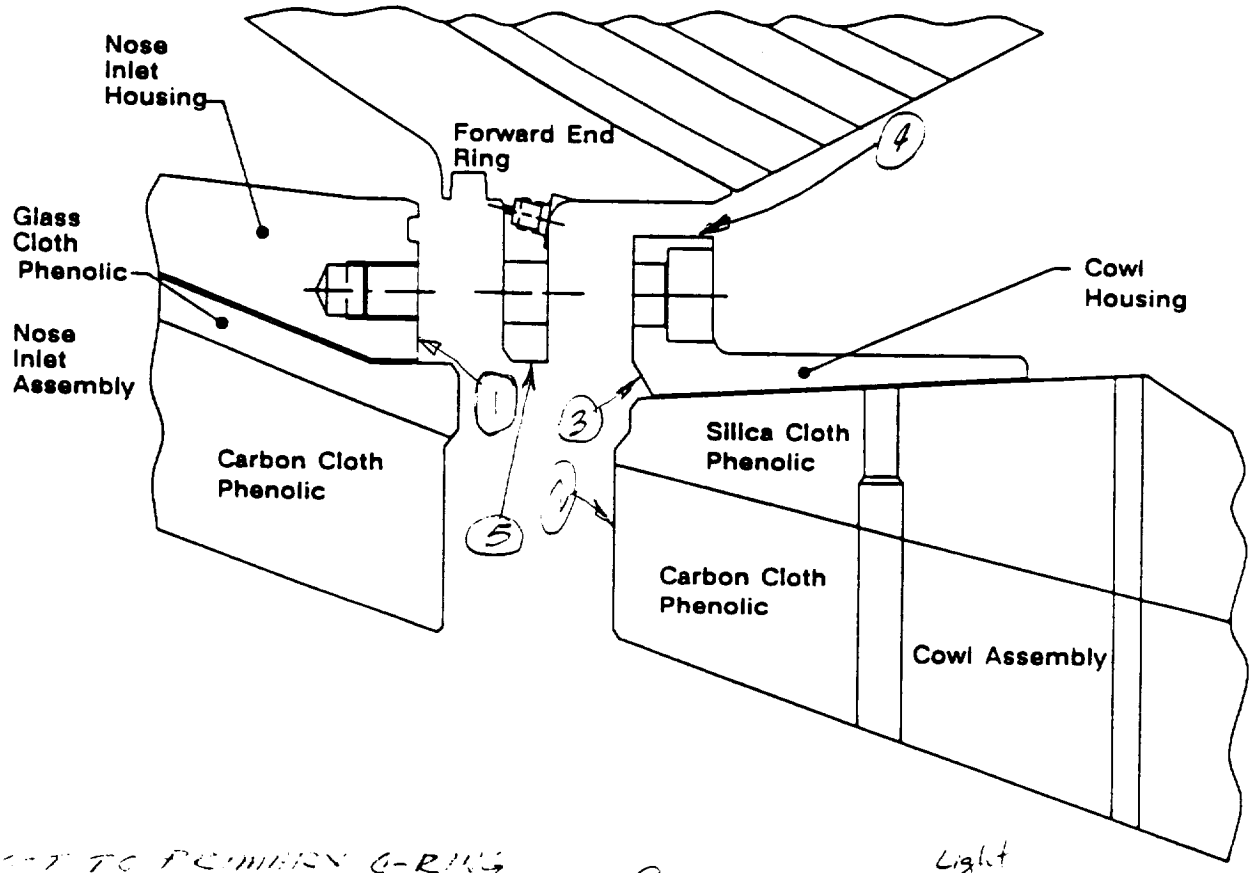
Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

POSTFLIGHT OBSERVATION RECORD (PFOR) C-3

Nose Inlet-to-Flex Bearing-to-Cowl Joint (Joint #2) Condition Drawing Worksheet

Motor No.: 360L029	Side: Right (B)	Date: 1/23/93
Assessment Engineer(s)/Inspector(s): R. QUICK, T. FREESTON		

Sketch Observations Below (include locations and sizes of sketched features):



1. SOOT TO PRIMARY O-RING AT 250°
2. RTV FULL COVERAGE 360° TYPICAL INTERMIXING OF [illegible] AND SEALS
3. Light INTERMITTENT CORROSION 360°
4. LIGHT CORROSION ON AFT EDGE OF COWL HSG ID FLANGE
5. INTERMITTENT SMALL AREAS OF MISSING PAINT (360°)

ification Form(s)? _____ Yes ___✓___ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-2

Internal Nozzle Joint Condition

Motor No.: 360L029	Side: Right (B)	Date: 1/28/93

Assessment Engineer(s)/Inspector(s): R. Quick T. Freston

Joint: Nose Inlet-to-Throat (Joint #3)

Internal Nozzle Joint Observations:	Yes	No	Comment #
A. Gas Penetration in the RTV (Terminated, Through)?		✓	
B. RTV Not Below Char Line?		✓	
C. RTV To the Primary O-ring?		✓	
D. RTV Past the Primary O-ring?		✓	
E. Uncured RTV?		✓	
F. Voids Within RTV?		✓	
G. Grease Inhibiting RTV Backfill?		✓	
H. Foreign Material?		✓	
I. Heat Affected or Eroded Virgin CCP, GCP/SCP, or adhesive?		✓	
J. Damaged Phenolics?		✓	
K. Bondline Edge Separations? Use Clarification Form.	✓	✓	SEE Pg C-31A
L. Phenolics Axially Displaced From Housing?		✓	
M. Heat Affected Metal?		✓	
N. Unbonded or Blistered Paint?		✓	
O. Corrosion?		✓	
P. Alignment Pin Damage?		N/A	
Q. Excessive Grease in Threaded Bolt Holes?		✓	
R. Bolt Hole Damage (Through, Threaded/Helical Coil Insert)?		✓	
S. Bent or Broken Bolts?		✓	
T. Metal Damage (Joints or Housings)?		✓	

Notes / Comments

minary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): C-31A

Nozzle Interface Separation Clarification Form

Motor No.: 360L029	Side: ☐ Left (A) ☒ Right (B)	Date: 1/28/93

Assessment Engineer(s)/Inspector(s): R. Quick T. Freston

Part:
- ☐ Forward Exit Cone (Forward End)
- ☐ Throat Ring (Aft End)
- * ☒ Throat Inlet Ring (Forward End)
- ☐ Aft Inlet Ring (Aft End)
- ☐ Nose Cap (Aft End)
- ☐ Cowl (Forward End)*
- ☐ Inner Boot Ring (Forward End)
- ** ☒ NOSE INLET FWD END

Interface Separation Types:

A. Metal-to-Adhesive
B. Within Adhesive
C. Adhesive-to-GCP
D. Within GCP
E. GCP-to-CCP
F. Within CCP
*G. Adhesive-to-SCP
*H. Within SCP
*I. SCP-to-CCP

Circumferential Location	Separation Type	Maximum Radial Width
* 0-360	A	.005
** 30-38	A	.005
** 130-140	A	.005

Corresponding Comment Number(s): _____

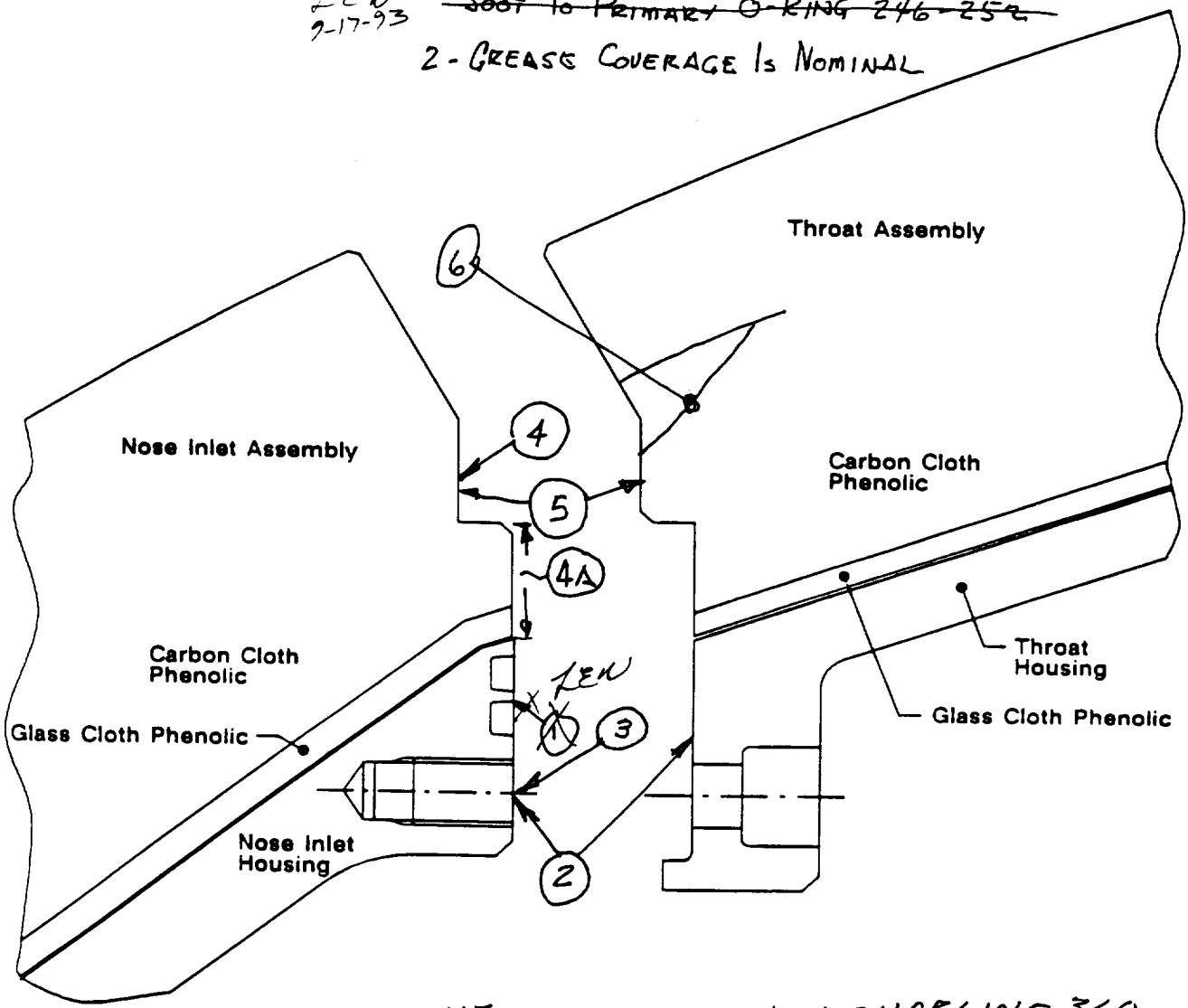
POSTFLIGHT OBSERVATION RECORD (PFOR) C-4

Nose Inlet-to-Throat Joint (Joint #3) Condition Drawing Worksheet

Motor No.: 360L029	Side: Right (B)	Date: 1/28/93
Assessment Engineer(s)/Inspector(s): R. Quick T. Freston		

Sketch Observations Below (include locations and sizes of sketched features):

~~1-TYPICAL SCALLOPED IN BETWEEN BOLT HOLES.~~
LEN 9-17-93 ~~SOOT TO PRIMARY O-RING 246-254~~
2-GREASE COVERAGE IS NOMINAL



3-NO EXCESS GREASE IN BOLT HOLES

4-RTV REACHED ~~IN~~ NOSE INLET HOUSING 360° EXCEPT FOR 4-A-LOC 295°-315°, & 345°-355°

5-RTV BELOW CHARLINE 360

6-PLY SEPARATION FROM 290°-300° GAP=.010

ification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-2
Internal Nozzle Joint Condition

Motor No.: 360L029	Side: Right (B)	Date: 1-26-93
Assessment Engineer(s)/Inspector(s): R. DUCL		
Joint: Throat-to-Forward Exit Cone (Joint #4)		

Internal Nozzle Joint Observations:	Yes	No	Comment #
A. Gas Penetration in the RTV (Terminated, Through)?		✓	
B. RTV Not Below Char Line?		✓	
C. RTV To the Primary O-ring?	✓		SEE PG C-34
D. RTV Past the Primary O-ring?		✓	
E. Uncured RTV?		✓	
F. Voids Within RTV?		✓	
G. Grease Inhibiting RTV Backfill?		✓	
H. Foreign Material?		✓	
I. Heat Affected or Eroded Virgin CCP, GCP/SCP, or adhesive?		✓	
J. Damaged Phenolics?		✓	
K. Bondline Edge Separations? Use Clarification Form.	✓		SEE PG C-33A
L. Phenolics Axially Displaced From Housing?		✓	
M. Heat Affected Metal?		✓	
N. Unbonded or Blistered Paint?		✓	
O. Corrosion?	✓		1, 2
P. Alignment Pin Damage?		✓	
Q. Excessive Grease in Threaded Bolt Holes?		✓	
R. Bolt Hole Damage (Through, Threaded/Helical Coil Insert)?		✓	
S. Bent or Broken Bolts?		✓	
T. Metal Damage (Joints or Housings)?		✓	

Notes / Comments

1. LIGHT TO MEDIUM CORROSION FROM 97°-107° AT SEAL REGION. CORROSION WAS NOT PRESENT IN THIS LOCATION.

2. MODERATE TO HEAVY CORROSION ON AFT END OF THROAT HSG BETWEEN PRIMARY & SECONDARY O-RING SEAL SURFACE FROM 180-205 AND 85°-140°

Preliminary PFAR(s)? _____ Yes _____ No Preliminary PFAR Number(s): _____

Clarification Form(s)? ✓ Yes _____ No Clarification Form Page No.(s): C-33A

Nozzle Interface Separation Clarification Form

Motor No.: 360L029	Side: ☐ Left (A) ☒ Right (B)	Date: 1/26/93

Assessment Engineer(s)/Inspector(s): R. QUICK

Part:
- ☒ Forward Exit Cone (Forward End)
- ☐ Throat Ring (Aft End)
- ☐ Throat Inlet Ring (Forward End)
- ☐ Aft Inlet Ring (Aft End)
- ☐ Nose Cap (Aft End)
- ☐ Cowl (Forward End)*
- ☐ Inner Boot Ring (Forward End)

Interface Separation Types:

A. Metal-to-Adhesive
B. Within Adhesive
C. Adhesive-to-GCP
D. Within GCP
E. GCP-to-CCP
F. Within CCP
*G. Adhesive-to-SCP
*H. Within SCP
*I. SCP-to-CCP

Circumferential Location	Separation Type	Maximum Radial Width
[illegible]°	A	[illegible]
[illegible]°	A	[illegible]
[illegible]°	E	[illegible]
[illegible]°	A	[illegible]

Corresponding Comment Number(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-5

Throat-to-Forward Exit Cone Joint (Joint #4) Condition Drawing Worksheet

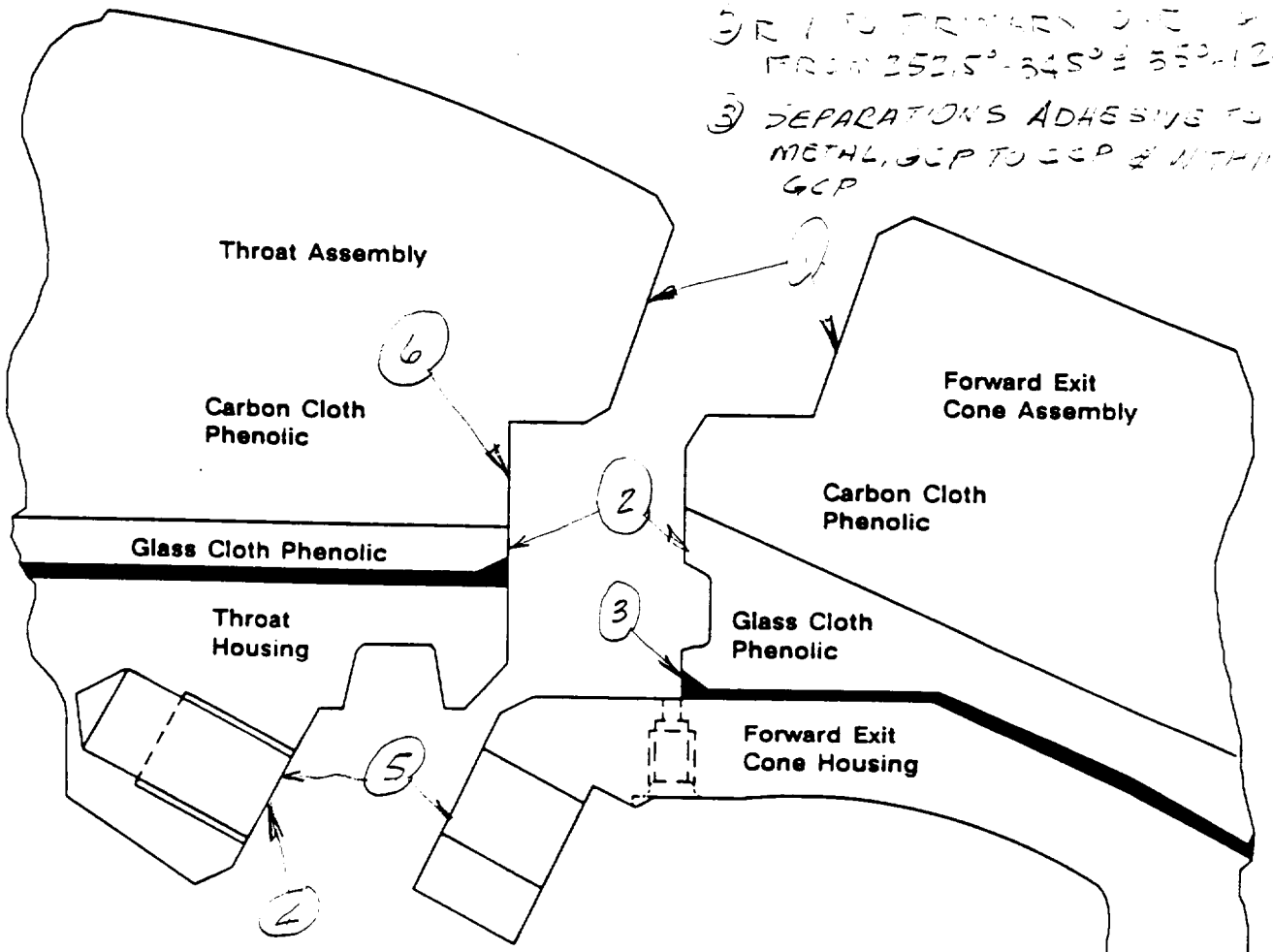
Motor No.: 360L029	Side: Right (B)	Date: 1/26 ??
Assessment Engineer(s)/Inspector(s): R. Quick		

Sketch Observations Below (include locations and sizes of sketched features):

1) RTV BELOW CHAR LINE FULL CIRCUMFERENCE

3) RTV TO PRIMER JOINT FROM 252.5°-345° & 55°-120°

3) SEPARATIONS ADHESIVE TO METAL, GCP TO GCP & WITHIN GCP



4) NO EXCESS GREASE IN HOLES

5) NOMINAL GREASE COVERAGE ON FLANGES

6) PHENOLIC DISCOLORED LOOKS RUSTY FROM 45 TO 188°

...ification Form(s)? _____ Yes _____ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-2
Internal Nozzle Joint Condition

Motor No.: 360L029	Side: Right (B)	Date: 27 JAN 1993

Assessment Engineer(s)/Inspector(s): JIM PASSMAN, TREVOR FRESTON

Joint: Aft End Ring-to-Fixed Housing (Joint #5)

Internal Nozzle Joint Observations:	Yes	No	Comment #
A. Gas Penetration in the RTV (Terminated, Through)?		✓	
B. RTV Not Below Char Line?		✓	
C. RTV To the Primary O-ring?	✓		(1)
D. RTV Past the Primary O-ring?		✓	
E. Uncured RTV?		✓	
F. Voids Within RTV?	✓		(2)
G. Foreign Material?		✓	
H. Heat Affected or Eroded Virgin CCP, GCP/SCP, or adhesive?		✓	
I. Damaged Phenolics?		✓	
J. Bondline Edge Separations? Use Clarification Form.		✓	
K. Phenolics Axially Displaced From Housing?		✓	
L. Heat Affected Metal?		✓	
M. Unbonded or Blistered Paint?		✓	
N. Corrosion?	✓		(3)
O. Alignment Pin Damage?		✓	
P. Excessive Grease in Threaded Bolt Holes?		✓	
Q. Bolt Hole Damage (Through, Threaded/Helical Coil Insert)?		✓	
R. Bent or Broken Bolts?		✓	
S. Metal Damage (Joints or Housings)?		✓	

Notes / Comments

(1) RTV TO PRIMARY O-RING AT 40°-70°, 130°, AND 220°-250°.

(2) LARGE VOID IN RTV COVERING AFT MOST END APPROX 0.5" WIDE x 10.3" CIRC FROM 140°-157°. LARGE VOID IN RTV (SAME LOCATION) FROM 165°-187°, 0.5" MAX WIDTH x 14.3" CIRC. SMALL VOIDS (0.2" x 0.3" TYP) INTERMITTENT 360°.

(3) CORROSION AS NOTED ON PFOR C-6 (PAGE C-36).

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

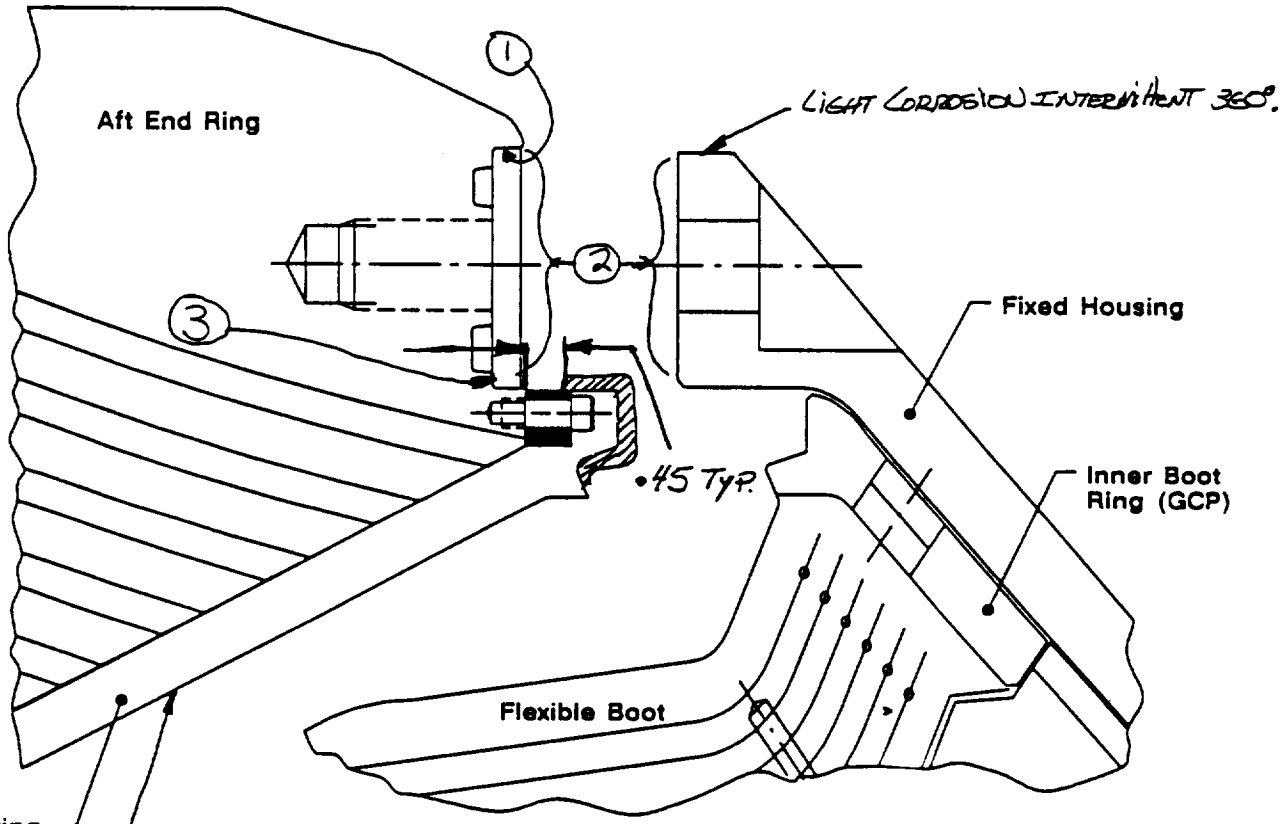
POSTFLIGHT OBSERVATION RECORD (PFOR) C-6

Aft End Ring-to-Fixed Housing Joint (Joint #5) Condition Drawing Worksheet

Motor No.: 360L029	Side: Right (B)	Date: 27 JAN 1993
Assessment Engineer(s)/Inspector(s): JIM PASEMAN, TREVOR FRESTON		

Sketch Observations Below (include locations and sizes of sketched features):

(1.) MEDIUM CORROSION INTERMITTENT [redacted] FROM 150°-0-80°.
(2.) NOMINAL GREASE COVERAGE. WATER IN NOTED AREA, APPEARS TO BE FROM DISASSEMBLY. LIGHT CORROSION ALSO FOUND IN NOTED AREA INTERMITTENT 360°.
(3.) RTV REACHED PRIMARY O-RING AT 40°-70°, 130°, AND 220°-250°



Clarification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

POSTFLIGHT OBSERVATION RECORD (PFOR) C-7

Cowl Insulation Segment Condition

Motor No.: 360L029	Side: ~~Left (A)~~ Right (B)	Date: 27/Jun/93

Assessment Engineer(s)/Inspector(s): PETE MILLER, L. WILKES

Cowl Insulation Segment Observations:	Yes	No	Comment #
A. Spring Pin Holes Completely Through the Cowl Segment?		✓	
B. Abnormal Heat Effects or Erosion?		✓	
C. Soot Between the Cowl Segment and Cowl Housing?		✓	
D. Bondline Failure Mode? Data Collection Only.	N/A	N/A	1

Notes / Comments	Adhesive metal	Adhesive segment	Cohesive segment
1) 0-45	20%	60%	20%
45-90	15%	55%	30%
90-135	50%	35%	15%
135-180	50%	30%	20%
180-225	50%	35%	15%
225-270	15%	70%	15%
270-315	50%	30%	20%
315-360	30%	50%	20%

minary PFAR(s)? _____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? _____ Yes U No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-8
Flexible Bearing, Flexible Bearing Protector, and Flexible Boot Condition

Motor No.: 360L029	Side: Right (B)	Date: 27 JAN 1993

Assessment Engineer(s)/Inspector(s): JIM PASSMAN, TREVOR PRESTON, WILKES

Flexible Bearing, Bearing Protector, and Boot Observations:	Yes	No	Comment #
A. Bearing Protector Burn-Through?		✓	
B. Cracks Through the Bearing Protector?		✓	
C. Bearing Protector Heat Effects or Erosion Other Than at Cowl Vent Hole Locations?		✓	
D. Soot Between the Bearing Protector and Flexible Bearing?		✓	
E. Heat Effects to the Flexible Bearing?		✓	
F. Bent or Broken Bearing Protector Bolts?		✓	
G. Flexible Boot Burn-Through?		✓	
H. Abnormal Heat Effects or Erosion to Flexible Boot ID?		✓	
I. Foreign Material in Boot Cavity?		✓	

Notes / Comments

Special Issue 3.3.1 NO ABNORMAL EROSION OR OTHER CONDITIONS WERE OBSERVED ON THE BEARING PROTECTOR OD OR ON THE FLEX BOOT ID AROUND FULL CIRCUMFERENCE.

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-9
Flexible Bearing Protector Thickness Measurements

Motor No.: 360L029	Side: Right (B)	Date: 2-[illegible]-93
Assessment Engineer(s)/Inspector(s): R. MATHESON, M ENRIQUEZ JR		

Record the Flexible Bearing Protector Gas Impingement Area Thickness Measurements (see figure) Below:

Degree Location	Thickness Measurement "A"* (inches)	Degree Location	Thickness Measurement "A"* (inches)	Degree Location	Thickness Measurement "A"* (inches)
0	.719	120	.682	240	.722
10	.712	130	.695	250	.672
20	.726	140	.688	260	.680
30	.735	150	.663	270	.662
40	.712	160	.696	280	.709
50	.725	170	.711	290	.722
60	.712	180	.716	300	.726
70	.704	190	.710	310	.691
80	.696	200	.715	320	.706
90	.703	210	.705	330	.714
100	.693	220	.713	340	.703
110	.693	230	.700	350	.725

700

02 02 93
17745 TW
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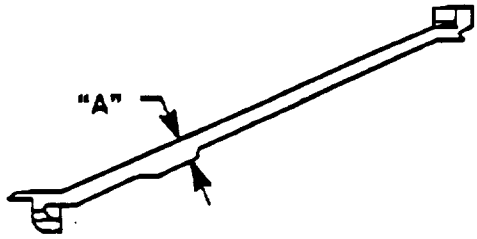


* "A" is the minimum thickness of the bearing protector in-line with the cowl vent holes. It corresponds to the deepest gas impingement location.

Notes / Comments

Preliminary PFAR(s)? ____ Yes ____ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ____ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-10
Throat Diameter Measurements (Data Collection Only)

Motor No.: 360L029	Side: Right (B)	Date: 01-28-93

Assessment Engineer(s)/Inspector(s): R.R. GALLEGOS, JED BENSON

Record the Nozzle Throat Diameter Measurements Below:

Degree Location	Diameter Measurement (inches)
0	55.983"
45	55.990"
90	55.982"
135	55.960

Notes / Comments

SL-45062

[illegible] ication Form(s)? _____ Yes ___✓___ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-11

Outer Boot Ring Char and Erosion Measurements and Flexible Boot Condition

Motor No.: 360L029	Side: Right (B)	Date: 3/3/93

Assessment Engineer(s)/Inspector(s): Jim Passman, Mark Clark

Flexible Boot/Outer Boot Ring Separation Observations:

	Yes	No	Comment #
A. Heat Effects in Boot/OBR Separation?		✓	

Record the Outer Boot Ring Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
8.0	—	0.93*	—	1.04*	—	1.01*	—	0.91*
9.0	0.08	0.85	0.06	0.87	0.09	0.84	0.04	0.84
10.0	0.11	0.87	0.05	0.88	0.08	0.82	0.03	0.86
11.3	0.18	0.81	0.07	0.98	0.06	0.70	0.09	0.87

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Record the Number of Plies Remaining on the Flexible Boot:

Degree Location	Plies Remaining
0	3.4
90	3.9
180	4.0
270	3.3

Negative Margin of Safety? ____ Yes ✓ No Degree: ____

Notes / Comments

* TOTAL (CHAR AND EROSION)

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Right (B)	Date: 5 FEB 1993
Assessment Engineer(s)/Inspector(s): JIM PASSMAN, PETE MILLER		
Phenolic Subassembly: Aft Exit Cone Assembly		

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location							
	0°-45°	45°-90°	90°-135°	135°-180°	180°-225°	225°-270°	270°-315°	315°-0°
Metal-to-Adhesive	—	5%	5%	50%	50%	25%	5%	5%
Within Adhesive								
Adhesive-to-GCP				20%	20%	30%	10%	5%
Within GCP	100%	95%	95%	30%	30%	45%	85%	90%
GCP-to-CCP								
Within CCP								

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

	Degree Location							
	0°-45°	45°-90°	90°-135°	135°-180°	180°-225°	225°-270°	270°-315°	315°-0°
Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-GCP	100%	100%	100%	100%	100%	100%	100%	100%

Phenolic Removal Method: WEDGE, HAND PEEL. VERY DIFFICULT, COULDN'T REMOVE ALL

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		(1)
C. Corrosion?	✓		(2)
D. Foreign Material?		✓	
E. Voids in Polysulfide (Aft Exit Cone Polysulfide Groove)?	✓		(3)

Notes / Comments
(1) ONE VOID NOTED AT 244°, LOCATED 20.2" FROM FWD END, MEASURING 0.60" AXIAL x 0.40" CIRC.
(2) MEDIUM CORROSION IN ADHESIVE/METAL FAILURE AREAS FROM 135°-270°.
(3) SMALL VOIDS LOCATED INTERMITTENTLY FULL CIRC. POLYSULFIDE DID NOT FULLY FILL GROOVE IN SEVERAL LOCATIONS.

minary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ✓ Yes Yes No (I.P.) Clarification Form Page No.(s): C-42A

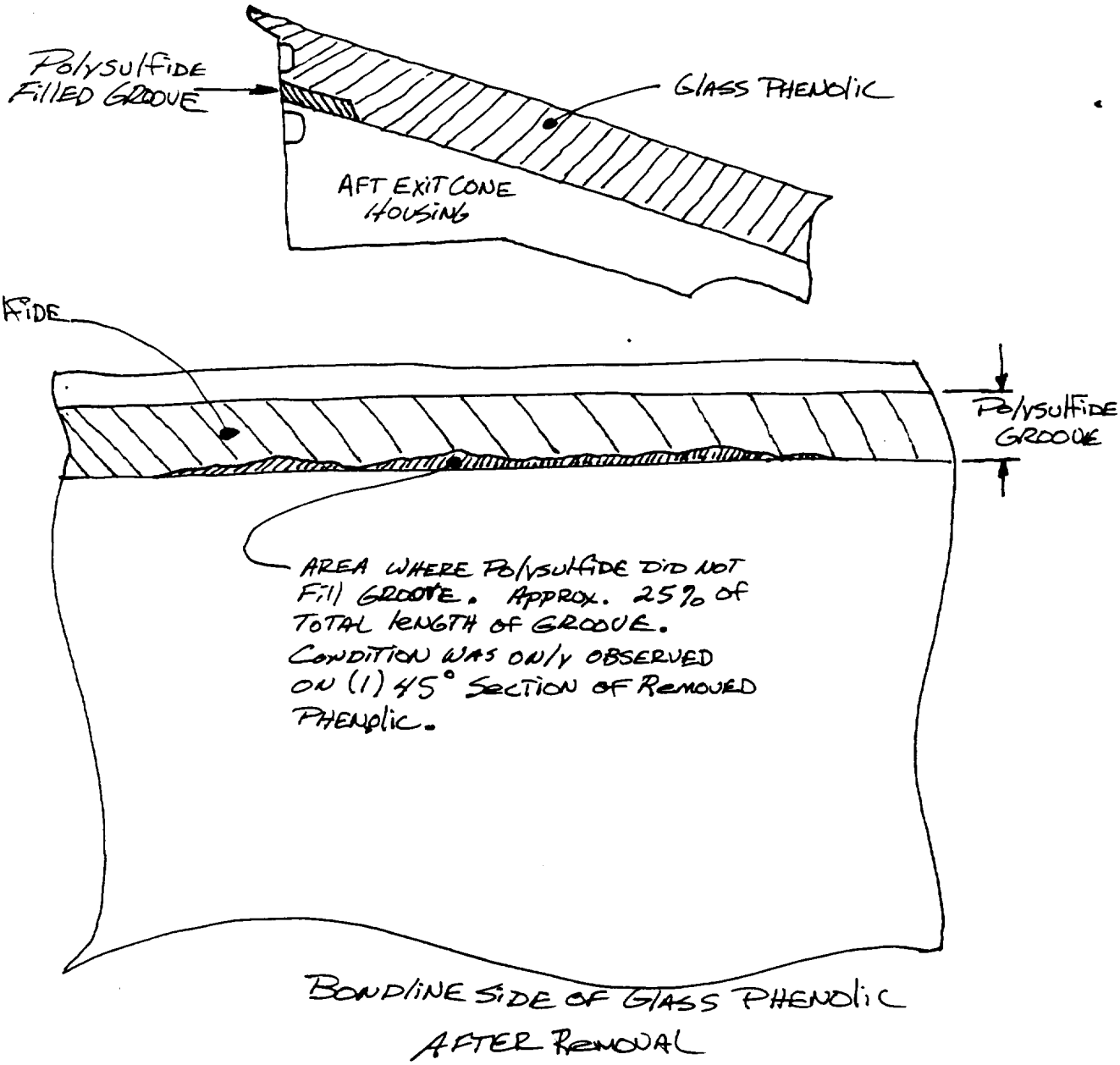
General Hardware Clarification Form

Motor No.: 360L029	Side: ☐ Left (A) ☑ Right (B)	Date: 10 FEB 1993

Assessment Engineer(s)/Inspector(s): JIM PASSMAN

Description: AFT EXIT CONE POLYSULFIDE GROOVE FILL

Sketch Observations Below (include locations and sizes of sketched features):



Corresponding Comment Number(s): (3)

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029 | Side: Right (B) | Date: 1-29-93

Assessment Engineer(s)/Inspector(s): WILKES/PRESTON/LANGE/[illegible]

Phenolic Subassembly: Forward Exit Cone Assembly

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

SEE NOTE 1

Degree Location

	0-90	90-180	180-270	270-360				[illegible]
Metal-to-Adhesive	25	30	25	20				25
Within Adhesive	10	10	10	10				10
Adhesive-to-GCP	65	60	65	70				65
Within GCP								
GCP-to-CCP								
Within CCP								

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

N.A.

Degree Location

Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-GCP								

Phenolic Removal Method: ______

Metal Housing Bondline Surface Observations:

	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		2
C. Corrosion?	✓		3
D. Foreign Material?		✓	

Notes / Comments ① SEE CLARIFICATION FORM PAGE C-43A FOR DEVIATIONS [illegible] NORMAL PHENOLIC REMOVAL PROCEDURES.
② SEE PFOR CLARIFICATION FORM PAGE C-43B.
③ TYPICAL MED-TO-HEAVY CORROSION INTERMITTENTLY AROUND 95% OF THE CIRCUMFERENCE OVER AFT 4-TO-8 INCHES AND AROUND 30% OF CIRCUMFERENCE [illegible] OVER FWD 2-TO-6 INCHES. NO CORROSION ON EXPOSED MID-SECTION METAL SURFACE. [illegible]

[Preli]minary PFAR(s)? ____ Yes ✓ No   Preliminary PFAR Number(s): ______

Clarification Form(s)? ✓ Yes ____ No   Clarification Form Page No.(s): C-43A&B

REVISION ____

Thiokol CORPORATION
SPACE OPERATIONS

General Hardware Clarification Form

Motor No.: 360L029	Side: ☐ Left (A) ☑ Right (B)	Date: 1-29-93

Assessment Engineer(s)/Inspector(s): WILKES/FRESTON/LANGE/SIMMONS

Description: PHENOLIC BONDLINE CONDITION, FWD EXIT CONE ASSEMBLY.

Sketch Observations Below (include locations and sizes of sketched features):

SEE CLARIFICATION FORM PAGE C-16A FOR NORMAL PROCEDURE OF REMOVING LINER REMOVAL.

THE ASM-29B NOZZLE FWD EXIT CONE HAD 4.0 TO 8.0 INCHES OF CONSTRICTOR REMAINING ON AFT END, AROUND FULL CIRCUMFERENCE IN 10 INCHES WIDE AXIALLY FROM 30° TO 340°. THE MIDDLE SECTION SHOWED CCP/GCP SEPARATIONS. AN AXIAL CUT WAS made THROUGH THE CCP TO THE GCP INTERFACE. TWO WEDGES WERE DRIVEN BETWEEN THE GCP AND CCP. THE AFT CCP SEGMENT SEPARATED AT GCP/CCP INTERFACE. THE FWD SEGMENT SEPARATED AT GCP/CCP INTERFACE EXCEPT FOR A SMALL WIDE, AXIAL, BAND AROUND CIRCUMFERENCE WAS WITH GCP SEPARATION. THIS BAND WAS LOCATED ONE INCH FROM FWD GCP SURFACE.

Corresponding Comment Number(s): 1

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☐ Left (A) ☑ Right (B)	Date: 2-2-93
Assessment Engineer(s)/Inspector(s): WILKES / MILLER		
Nozzle Subassembly: FWD EXIT CONES		

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size		Location on Bonding Surface	
	Axial	Circ.	Distance From Fwd	Distance From Aft
	.60	.30		E.70

Notes / Comments (1) VERY FEW SMALL ADHESIVE VOIDS WERE OBSERVED INTERMITTENTLY AROUND CIRCUMFERENCE.

Corresponding Comment Number(s): 2

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Right (B)	Date: 29 JAN 1993

Assessment Engineer(s)/Inspector(s): JIM PASSMAN, TREVOR FRESTON

Phenolic Subassembly: Throat Assembly

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location							
	45°-135°	135°-225°	225°-315°	315°-45°				total
Metal-to-Adhesive	75	100	100	100				94
Within Adhesive								
Adhesive-to-GCP	20							5
Within GCP	5							1
GCP-to-CCP								
Within CCP								

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

	Degree Location							
Metal-to-Adhesive		N/A						
Within Adhesive								
Adhesive-to-GCP								

Phenolic Removal Method: _____

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		(1)
C. Corrosion?	✓		
D. Foreign Material?		✓	

Notes / Comments
(1) WORMHOLE VOIDS ON AFT 8.5" OF 45°-135° SECTION. MAX CONDITION MEASURES 6.5" AXIAL by 2.5" CIRC.. A FEW SMALL VOIDS (0.40" MAX DIA) TYPICALLY AT 0.10" to 0.25" DIA WERE FOUND SCATTERED AROUND THE CIRCUMFERENCE.
(2) CORROSION - MEDIUM to HEAVY FOUND ON ALL AREAS OF METAL TO ADHESIVE FAILURE.

Preliminary PFAR(s)? _____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Right (B)	Date: 2/4/93
Assessment Engineer(s)/Inspector(s): R.QUICK T.FRESTON		
Phenolic Subassembly: Aft Inlet/Forward Nose Rings		

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location								
	0-45	45-90	90-135	135-180	180-225	225-270	270-315	315-0	
Metal-to-Adhesive	100%	100%	100%	100%	100%	100%	60%	100%	95
Within Adhesive									
Adhesive-to-GCP							40%		5
Within GCP									
GCP-to-CCP									
Within CCP									

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

	Degree Location							
Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-GCP								

Phenolic Removal Method: _____

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		SEE SPECIAL ISSUES
C. Corrosion?	✓		1
D. Foreign Material?		✓	

Notes / Comments 1-MEDIUM CORROSION 340° 296° NO LDI INDICATION

Special Issue 3.3.7 144° AT 148° AXIAL=.32, CIRCUM=.42 (LDI)

Special Issue 3.3.11 90° DEPTH .02 AXIAL .33 CIRCUM.25 (LDI) 335° DEPTH .02 AXIAL .70 CIRCUM .40 (LDI)

minary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Right (B)	Date: 7/2/93
Assessment Engineer(s)/Inspector(s): R. QUICK T. FRESTON		
Phenolic Subassembly: Nose Cap		

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location							
	0-45	45-90	90-135	135-180	180-225	225-270	270-315	315-0
Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-GCP								
Within GCP								
GCP-to-CCP	100%	100%	100%	100%	100%	100%	100%	100%
Within CCP								

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

	Degree Location							
	0-45	45-90	90-135	135-180	180-225	225-270	270-315	315-0
Metal-to-Adhesive	20%	20%	20%	20%	20%	20%	20%	20%
Within Adhesive								
Adhesive-to-GCP	80	80	80	80	80	80	80	80

Phenolic Removal Method: _____

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		SEE SPECIAL ISSUES
C. Corrosion?	✓		1
D. Foreign Material?		✓	

Notes / Comments 1-LIGHT CORROSION AFT 3.0IN & FWD 1.5-2.0IN. FULL CIRCUM
177° NO INDICATION

Special Issue 3.3.4 90° DEPTH .02, AXIAL = .37, CIRCUM = .25, 335° DP .02, AXIAL = .75, CIRCUM = .40 (LDI)
191° DEPTH .03 AXIAL = .20, CIRCUM = .23 (LDI)

Special Issue 3.3.5 121° NO INDICATION
210° NO INDICATION

Special Issue 3.3.11 SEE PG C-45

minary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Right (B)	Date: 1-28-93

Assessment Engineer(s)/Inspector(s): WILKES / TELLERS

Phenolic Subassembly: Cowl Assembly

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location							
	0-360							
Metal-to-Adhesive	100							
Within Adhesive								
Adhesive-to-SCP								
Within SCP								
SCP-to-CCP								
Within CCP								

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

1'A

	Degree Location							
Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-SCP								

Phenolic Removal Method: _____

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		✓	
B. Voids in Adhesive?	✓		1
C. Corrosion?	✓		2
D. Foreign Material?		✓	

Notes / Comments ① SEE PFOR CLARIFICATION FORM PAGES C-47A, B, C.
② SEE NOTES ON CLARIFICATION FORM PAGE C-47D.
Special Issue 3.3.8 — SEE CLARIFICATION FORM PAGE C-47A NOTE 2.
(3)
(4) Special Issue 3.3.11 — SEE CLARIFICATION FORM PAGE C-47C NOTES 1 & 2.

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): _____

Clarification Form(s)? ✓ Yes ____ No Clarification Form Page No.(s): C-47A, B, C & D

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☐ Left (A) ☑ Right (B)	Date: 1-28-93
Assessment Engineer(s)/Inspector(s): WILKES / TELLERS		
Nozzle Subassembly: COWL		

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size Axial	Void Size Circ.	Location on Bonding Surface: Distance From Fwd FROM CHAM CORNER	Location on Bonding Surface: Distance From Aft
44	.30	.05	0.50	
44.5	.30	.10	0.60	
47	.35	.20	0.50	
47	.45	.20	2.40	
47	.40	.10	2.95	
49	.10	.45	2.70	
50	.15	.65	0.30	
50	.70	.05	1.75	
51	.10	.30	1.80	
52	.20	.30	2.00	
52	.35	.10	1.70	
55	.90	.10	0.90	
57	.30	.10	0.10	

Notes / Comments (1) MANY SMALL ADHESIVE VOIDS, 0.25 IN. DIA. MAX, WERE OBSERVED FROM 44° TO 80°. VERY FEW VOIDS WERE OBSERVED AROUND REMAINING CIRCUMFERENCE.

(2) NO ADHESIVE VOIDS WERE OBSERVED AT 7° AND 9°. HOWEVER ADHESIVE FILLED METAL SURFACE PIT REPAIR AREAS WERE OBSERVED AT 8° AND 10° WHICH ALMOST CORRELATES TO NOTED LDI SIZES. IT SHOULD BE NOTED THAT A REPAIR AREA ON THE HOUSING AT 0° HAS NO RESPECTIVE LDI LISTED.

Corresponding Comment Number(s): 1, 3

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☐ Left (A) ☑ Right (B)	Date: 1-28-93
Assessment Engineer(s)/Inspector(s): WILKES / TELLERS		
Nozzle Subassembly: COWL		

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size Axial	Void Size Circ.	Location on Bonding Surface: Distance From Fwd (FROM CHAM CORNER)	Location on Bonding Surface: Distance From Aft
57	.40	.10	0.50	
58.5	.10	.30	0.85	
58.5	.10	.30	1.55	
[illegible]	.90	.15	0.30	
51-63	.70	3.80	0.00	
59.5	.35	.05	1.85	
61	.40	.15	0.70	
62	.55	.10	1.70	
64	.70	.10	1.00	
66	.35	.05	1.95	
67	.40	.10	0.90	
69.5	.40	.10	0.90	
70	.35	.10	0.30	

Notes / Comments

① A LIGHT GREEN STAIN WAS OBSERVED IN THE ADHESIVE AFT FROM SPRING PIN AT 130° TO AFT END OF INSULATOR AT MEASURED 1.50 IN. CIRCUMFERENCE. THERE WAS NO EVIDENCE OF THIS STAIN AT CORRESPONDING LOCATION ON METAL HOUSING.

Corresponding Comment Number(s): 1

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☐ Left (A) ☑ Right (B)	Date: 1-28-93
Assessment Engineer(s)/Inspector(s): WILKES / TELLERS		
Nozzle Subassembly: COWL		

Record Bondline Adhesive Void Measurements and Locations Below:
SURFACE METAL HOUSING PIT REPAIRS.

Degree Location	Void Size Axial	Void Size Circ.	Location on Bonding Surface: Distance From Fwd FROM CHAM CORNER	Location on Bonding Surface: Distance From Aft
79.5	.50	.10	0.10	
76	.30	.10	0.00	
225	.30	.05	3.60	
276	.30	.15	0.20	
* 0	.40	.50	0.50	
* 8	.30	.30	0.30	
* 10	.40	.40	0.50	
* 261	.20	.50	ON CHAM SURFACE	
* 272	.25	.45	ON CHAM SURFACE	

* METAL HOUSING BONDLINE SURFACE PIT REPAIR AREAS

Notes / Comments (1) SEE PFCR CLARIFICATION FORMS PAGES C-47A, B & C FOR ADHESIVE VOIDS.

(2) FIVE METAL HOUSING PIT REPAIR AREAS WERE LOCATED AS DESCRIBED IN LAST ITEMS IN ABOVE CHART. PHOTOS WERE NOT TAKEN BECAUSE REPAIR AREAS WERE TOO SHALLOW TO APPEAR IN PHOTOS.

Corresponding Comment Number(s): 1, 4

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline ~~Adhesive Void~~ Clarification Form

Motor No.: 360L029	Side: ☐ Left (A) ☑ Right (B)	Date: 1-28-93
Assessment Engineer(s)/Inspector(s): WILKES / TELLERS		
Nozzle Subassembly: COWL		

Record Bondline ~~Adhesive Void~~ CORROSION Measurements and Locations Below:

Degree Location	Void Size Axial	Void Size Circ.	Location on Bonding Surface Distance From Fwd FROM CLEAN CORNER	Location on Bonding Surface Distance From Aft
3	2.80	0.20	0.00	
7	2.90	0.20	0.00	
40-43	1.00	2.50	0.00	
294-302	3.50	6.00	0.00	
310-318	2.00	5.00	0.00	

Notes / Comments (1) TYPICAL LIGHT-TO-MEDIUM AL. OXIDE CORROSION WAS OBSERVED OVER FULL BONDLINE SURFACE.

(2) FIVE AREAS OF DARK GRAY MEDIUM CORROSION WERE OBSERVED AS LISTED IN ABOVE CHART. THE TWO AT 3° & 7° WERE VERY SIMILAR AND PARALLEL PATTERNS.

Corresponding Comment Number(s): 2

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-12
Nozzle Subassembly Phenolic Bondline Condition

Motor No.: 360L029	Side: Right (B)	Date: 3/Feb/93
Assessment Engineer(s)/Inspector(s): Jim Passman, Pete Miller		
Phenolic Subassembly: Fixed Housing Assembly		

Record Primary Bondline/Phenolic Failure Mode Percentage (After Hydrolase and Wedge Removal):

	Degree Location								
	0-45	45-90	90-135	135-180	180-225	225-270	270-315	315-360	Total
Metal-to-Adhesive	15	3	5	5	10	15	15	10	10
Within Adhesive									
Adhesive-to-GCP									
Within GCP	85	97	95	95	90	10	15	90	72
GCP-to-CCP						75	70		18
Within CCP									

Record Secondary Bondline Failure Mode Percentage (After Removal of Remaining Phenolics):

	Degree Location							
	0-45	45-90	90-135	135-180	180-225	225-270	270-315	315-360
Metal-to-Adhesive								
Within Adhesive								
Adhesive-to-GCP	100	100	100	100	100	100	100	100

Phenolic Removal Method: _____

Metal Housing Bondline Surface Observations:	Yes	No	Comment #
A. Soot?		V	
B. Voids in Adhesive?	V		1
C. Corrosion?		V	
D. Foreign Material?		V	

Notes / Comments
1) See clarification Form

Preliminary PFAR(s)? ____ Yes ___V___ No Preliminary PFAR Number(s): _____

Clarification Form(s)? ___V___ Yes ____ No Clarification Form Page No.(s): C-48A

Thiokol CORPORATION
SPACE OPERATIONS

Nozzle Subassembly Bondline Adhesive Void Clarification Form

Motor No.: 360L029	Side: ☐ Left (A) ☑ Right (B)	Date: 3 FEB 1993
Assessment Engineer(s)/Inspector(s): Jim Passmann, Pete Miller		
Nozzle Subassembly: Fixed Housing		

Record Bondline Adhesive Void Measurements and Locations Below:

Degree Location	Void Size Axial	Void Size Circ.	Location on Bonding Surface Distance From Fwd	Location on Bonding Surface Distance From Aft
30°	0.50	0.30	—	3.9
182°	0.60	0.20	—	4.9
235°	0.50	0.20	—	1.2
268°	0.80	0.30	—	2.1
315°	0.50	0.30		0.70

Notes / Comments

Corresponding Comment Number(s): C-48 (1)

POSTFLIGHT OBSERVATION RECORD (PFOR) C-13
Cowl Ring Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Right (B)	Date: 6-10-93

Assessment Engineer(s)/Inspector(s): M Clark

Cowl Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Cowl Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
0.3	.21	.52	.23	.57	.24	.54	.27	.54
1.0	.34	.51	.26	.62	.30	.53	.25	.56
2.0	.21	.61	.31	.54	.34	.50	.33	.60
3.0	.37	.61	.30	.54	.37	.47	.34	.57
4.0	.37	.59	.34	.58	.35	.50	.29	.67
5.0	.37	.59	NA	NA	NA	NA	NA	NA
6.0	—	0.99*	—	0.98*	—	0.92*	—	1.05*
6.8	—	0.69*	—	0.99*	—	0.99*	NA	NA

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments * TOTAL (CHAR AND EROSION)

Special Issue 3.3.9

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-14

Forward Exit Cone Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Right (B)	Date: 6-10-93

Assessment Engineer(s)/Inspector(s): M. Clark

Forward Exit Cone Phenolic Section Observations:	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Forward Exit Cone Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
1.0	NA	NA	.37	.71	.39	.67	.41	.67
4.0			.33	.69	.35	.72	.36	.70
4.6			.32	.70	.34	.74	.35	.71
8.0			.31	.74	.34	.68	.34	.67
12.0			NA	NA	NA	NA	NA	NA
16.0								
20.0								
24.0								
28.0					NA	NA	NA	NA
32.0					.15	.71	.19	.68
32.9					.19	.66	.19	.67
34.0	NA	NA	NA	NA	.19	.69	.19	.65

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ✓ Yes ____ No Clarification Form Page No.(s): C-50A

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-19

Forward Exit Cone Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Right (B)	Date: 4-8-93

Assessment Engineer(s)/Inspector(s): L.E. WILKES

AFT Exit Cone Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Forward Exit Cone Char and Erosion Measurements Below:

Station Location	180° Erosion	180° Char	190° Erosion	190° Char	200° Erosion	200° Char	210° Erosion	210° Char
118.77	NA	NF	.150	.640	.140	.520	NA	NF
113.77	.150	.600	.190	.570	.170	.570	.180	.600
107.77	.140	.580	.150	.560	.160	.510	.160	.570
101.77	.130	.510	.130	.560	.130	.570	.140	.560
95.77	NF	NF	.120	.550	.120	.600	.110	.570
89.77			NA	NF	.110	.560	NA	NF
83.77					NA	NF		
77.77								
73.77								

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-15
Fixed Housing Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Right (B)	Date: 6-10-93
Assessment Engineer(s)/Inspector(s): M. Cu...		

Fixed Housing Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Fixed Housing Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
0.0	.1[illegible]	.15	.08	1.16	.1[illegible]	.95	0	1.31
1.0	.06	.96	.04	.[illegible]1	.10	.94	.04	.[illegible]1
2.0	[illegible]	.95	0	.92	0	.[illegible]6	0	.[illegible]3
3.0	[illegible]	.[illegible]3	0	.89	0	.[illegible]6	0	.[illegible]1
4.0	[illegible]	.83	0	.91	0	.95	0	.[illegible]0
5.0	[illegible]	.81	0	.97	0	.93	0	.[illegible]9
6.0	[illegible]	.94	0	.92	0	.97	0	.[illegible]7
7.0	[illegible]	.[illegible]7	0	.[illegible]7	0	.91	0	[illegible]
8.0	[illegible]	.71	[illegible]	.61	[illegible]	.91	0	.[illegible]6
9.0	.12	.52	.[illegible]1	.54	.06	.74	[illegible]	[illegible]A
10.75	.18	1.45	[illegible]A	[illegible]A	.24	1.39	[illegible]A	[illegible]

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments

[illegible]minary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

[illegible]ification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-16

Throat Inlet Assembly Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Right (B)	Date: 3/3/93
Assessment Engineer(s)/Inspector(s): JIM PASSMAN, CASEY WILKES		

Throat Inlet Assembly Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Throat Inlet Ring and Throat Ring Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
1.0	1.06	0.65	1.06	0.72	1.10	0.57	1.06	0.53
2.0	1.09	0.67	1.07	0.75	1.12	0.57	1.13	0.51
4.0	1.13	0.68	1.14	0.67	1.16	0.64	1.17	0.64
6.0	1.17	0.66	1.18	0.69	1.19	0.64	1.21	0.64
8.0	1.19	0.58	1.19	0.62	1.19	0.56	1.23	0.55
10.0	1.19	0.60	1.19	0.61	1.18	0.53	1.21	0.50
12.0	1.15	0.56	1.16	0.62	1.16	0.53	1.18	0.57
14.0	1.14	0.55	1.13	0.65	1.15	0.53	1.15	0.59
16.0	1.09	0.55	1.08	0.68	0.99	0.69	1.00	0.68
18.0	0.99	0.56	0.97	0.66	0.98	0.63	0.96	0.64
20.0	0.81	0.61	0.84	0.59	0.81	0.67	0.78	0.66
22.0	0.56	0.67	0.54	0.70	0.53	0.70	0.56	0.63
23.0	0.45	0.75	0.46	0.74	0.46	0.70	0.42	0.68

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-17
Nose Cap Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Right (B)	Date: 3/3/93

Assessment Engineer(s)/Inspector(s): Jim. PASSMAN, CAREY WILKES

Nose Cap Phenolic Section Observations:

	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Nose Cap Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
1.5	NA	NA	NA	NA	NA	NA	NA	NA
4.0	0.34	0.49	0.36	0.57	0.39	0.51	0.40	0.44
6.0	0.35	0.53	0.35	0.60	0.44	0.51	0.39	0.46
8.0	0.43	0.51	0.41	0.51	0.46	0.50	0.46	0.44
10.0	0.47	0.49	0.43	0.50	0.54	0.46	0.48	0.48
12.0	0.53	0.46	0.51	0.52	0.59	0.45	0.55	0.45
14.0	0.62	0.41	0.58	0.52	0.71	0.39	0.64	0.42
16.0	0.68	0.47	0.67	0.47	0.75	0.41	0.72	0.46
18.0	0.82	0.46	0.75	0.46	0.90	0.46	0.83	0.40
20.0	1.02	0.40	0.97	0.50	1.18	0.37	1.06	0.39
22.0	1.52	0.56	1.45	0.67	1.72	0.51	1.59	0.57
24.0	1.68	0.61	1.64	0.73	1.85	0.64	1.76	0.74
26.0	1.19	0.70	1.18	0.69	1.19	0.68	1.29	0.76

Negative Margin of Safety? _____ Yes ✓ No Station: _____ Degree: _____

Notes / Comments

'iminary PFAR(s)? _____ Yes ✓ No Preliminary PFAR Number(s): _____

ification Form(s)? _____ Yes ✓ No Clarification Form Page No.(s): _____

Thiokol CORPORATION
SPACE OPERATIONS

POSTFLIGHT OBSERVATION RECORD (PFOR) C-18
Forward Nose Ring and Aft Inlet Ring Phenolic (CCP) Section Condition

Motor No.: 360L029	Side: Right (B)	Date: 3/3/93

Assessment Engineer(s)/Inspector(s): Jim Passman, Larry Wilks

Forward Nose and Aft Inlet Ring Phenolic Section Observations:	Yes	No	Comment #
A. Cross-ply cracking in virgin material?		✓	
B. Ply lifting?		✓	

Record the Forward Nose Ring (-503) Char and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
28.0	1.15	0.69	1.08	0.73	1.12	0.59	1.19	0.64
30.0	0.92	0.63	0.92	0.63	0.98	0.63	0.99	0.55
32.0	0.98	0.59	0.95	0.62	1.01	0.60	1.05	0.54

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Record the Aft Inlet Ring Char (-504) and Erosion Measurements Below:

Station Location	0° Erosion	0° Char	90° Erosion	90° Char	180° Erosion	180° Char	270° Erosion	270° Char
34.0	0.89	0.58	0.99	0.48	0.94	0.56	0.97	0.53
36.0	0.91	0.59	0.99	0.53	0.97	0.55	0.95	0.55
38.0	0.95	0.60	0.98	0.51	1.01	0.61	0.97	0.51
39.0	0.97	0.67	1.01	0.62	1.04	0.59	0.99	0.56

Negative Margin of Safety? ____ Yes ✓ No Station: ____ Degree: ____

Notes / Comments

Preliminary PFAR(s)? ____ Yes ✓ No Preliminary PFAR Number(s): ____

Clarification Form(s)? ____ Yes ✓ No Clarification Form Page No.(s): ____

V. K. Henson, SA51
E613/RMP-FY94-181

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